Pollutant of Concern Modeling in the Syracuse Urbanized Area Using the Watershed Treatment Model (WTM)

FINAL Report

Onondaga County, New York

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Central New York Regional Planning & Development Board

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1. Introduction

As part of the Municipal Separate Storm Sewer System Phase II Stormwater Permit Implementation Program funded through the Environmental Protection Fund, the Central New York Regional Planning & Development Board (CNY RPDB) contracted with the C&S Companies to provide computer modeling services to evaluate loading of Pollutants of Concern (POCs) to impaired waters in the Syracuse Urbanized Area (SUA) in Onondaga County, New York. This effort was undertaken in partnership with regulated Municipal Separate Storm Sewer System (MS4) operators located in the SUA to demonstrate No Net Increase in those pollutants to the respective water bodies as required by the New York State Pollutant Discharge Elimination System General Stormwater (SPDES) Permit for Municipal Separate Storm Sewer System (MS4) Operators.

Section III.B of the SPDES General Permit for Discharges of Stormwater from MS4s (GP-0-10-002) requires that covered entities periodically evaluate their StormWater Management Plan (SWMP). MS4s are required to demonstrate that there are No Net Increases in discharge of stormwater POCs to the impaired waters for storm sewersheds that have undergone non-negligible changes. Non-negligible changes can include changes to land use and impervious cover greater than one acre or stormwater management practices implemented during the time that the MS4 has been covered by the permit.

The intent of the project is to provide both a baseline analysis (2008 data) and a first milestone analysis (2011 data) of POC loading to identified, impacted watercourses. The results of the analyses can be used to evaluate the effectiveness of each MS4's SMWP. In order to provide the most usable data set, the study areas were divided at both municipal and SUA boundaries (as designated by the U.S. Census Bureau - 2000). These divisions create a framework under which the participating municipalities can gauge compliance with the General Permit and, if necessary, develop management policies and provide accurate guidance to their constituents and development project applicants.

The long term goal is to provide MS4s a tool to show that they are evaluating their SWMP with respect to the MS4's effectiveness in achieving No Net Increase in the discharge of stormwater POCs as described above. This tool will be valuable to MS4s if it is straightforward, understandable, and relatively easy to implement on a recurring basis.

1.1. Project Description

Under the guidance of the CNY RPDB, C&S constructed a series of models to evaluate loading of POCs to designated bodies of water within the SUA from each of 25 impacted Municipal Separate Storm Sewer Systems (MS4s). The Watershed Treatment Model (WTM), developed by Center for Watershed Protection, was used to complete the work. C&S was responsible to deliver the completed modeling program to CNY RPDB in a format that can be readily used and updated in the future to account for both physical and program changes taking place in the subject watersheds.

The study area for this project consisted of the storm sewersheds, as defined by New York State Department of Environmental Conservation (NYSDEC) technical guidance, draining directly to bodies of water designated as impaired on the NY State 303(d) list. The units modeled were the sewersheds draining to each designated impaired water body within each municipal jurisdiction, including areas both within and outside the "Urbanized Area" as designated by the U.S. Census Bureau. Since the requirement pertains solely to areas that drain directly to the impaired segments identified, areas within the subwatersheds that do not discharge directly to the identified impaired segments were omitted from the analysis.

The municipal jurisdictions subject to the permit requirement are as follows:

Baldwinsville Village
Camillus Town
Camillus Village
Cicero Town
Clay Town
DeWitt Town
East Syracuse Village
Fayetteville Village
Geddes Town
LaFayette Town
Liverpool Village
Lysander Town
Manlius Town
Manlius Village
Marcellus Town
Minoa Village
North Syracuse Village
Onondaga County
Onondaga Town
Pompey Town
Salina Town
Solvay Village
Syracuse City
Van Buren Town

C&S was responsible for the collection and compilation of data as needed to prepare WTMs for the study area to represent conditions as of the end of 2011 and as of May 1, 2008. C&S prepared a final model package, consisting of the completed spreadsheet models and a report describing the data inputs and how they were obtained, modeling methodology and rationale, and outputs along with interpretation and discussion relative to the MS4 General Permit requirement of ensuring No Net Increase in POCs to impaired waters.

The following are the 303(d)-listed watercourses in Onondaga County that are affected by urban runoff from MS4s:

Water Index Number	County	Waterbody Name	Pollutant
Ont 66-11-P26-37- 6- 2	Onondaga	Limestone Creek, Lower, and minor tribs	pathogens
Ont 66-12 (portion 2)	Onondaga	Seneca River, Lower, Main Stem	pathogens
Ont 66-12-12-P154 (portion 1)	Onondaga	Onondaga Lake, northern end	phosphorus
Ont 66-12-12-P154 (portion 2)	Onondaga	Onondaga Lake, southern end	pathogens
Ont 66-12-12-P154 (portion 2)	Onondaga	Onondaga Lake, southern end	phosphorus
Ont 66-12-12-P154-	Onondaga	Minor Tribs to Onondaga Lake	phosphorus
Ont 66-12-12-P154-	Onondaga	Minor Tribs to Onondaga Lake	pathogens
Ont 66-12-12-P154- 2	Onondaga	Bloody Brook and tribs	pathogens
Ont 66-12-12-P154- 3	Onondaga	Ley Creek and tribs	pathogens
Ont 66-12-12-P154- 3	Onondaga	Ley Creek and tribs	phosphorus
Ont 66-12-12-P154- 4	Onondaga	Onondaga Creek, Lower, and tribs	phosphorus
Ont 66-12-12-P154- 4	Onondaga	Onondaga Creek, Lower, and tribs	pathogens
Ont 66-12-12-P154- 4	Onondaga	Onondaga Creek, Middle, and tribs	silt/sediment
Ont 66-12-12-P154- 4	Onondaga	Onondaga Creek, Middle, and tribs	phosphorus
Ont 66-12-12-P154- 4	Onondaga	Onondaga Creek, Middle, and tribs	pathogens
Ont 66-12-12-P154- 4	Onondaga	Onondaga Creek, Upper, and minor tribs	silt/sediment
Ont 66-12-12-P154- 5	Onondaga	Harbor Brook, Lower, and tribs	phosphorus
Ont 66-12-12-P154- 5	Onondaga	Harbor Brook, Lower, and tribs	pathogens
Ont 66-12-12-P154- 6	Onondaga	Ninemile Creek, Lower, and tribs	phosphorus
Ont 66-12-12-P154- 6	Onondaga	Ninemile Creek, Lower, and tribs	pathogens

2. Discussion of Technique to Demonstrate Compliance

2.1. Stormwater Quality Modeling

Pollutant loading in stormwater runoff, especially from non-point sources, is a complicated process with a substantial number of botanical, chemical, meteorological, and physical sub-processes. Many of these sub-processes are not easily quantified. Some stormwater quality models include thorough, detailed calculations of pollutant loading by mimicking many of the sub-processes. These types of calculations can require a tremendous amount of effort, data, and experience to implement. Other stormwater quality models are simpler with fewer input variables. These models often rely on field observations of pollutant loading rates and relatively broad assumptions based on a smaller number of variables and processes. While the effectiveness of both complex and simple models can be debated, both types of models can be appropriately used in a range of applications.

2.2. Selection of WTM for Compliance Demonstration

CNY RPDB elected to use the WTM to complete the work for this project. The approach and reasoning was discussed and agreed upon with the New York State Department of Environmental Conservation (NYSDEC) at the regional and state levels. The WTM provides an effective tool for MS4s to evaluate their success in implementing all six Minimum Control Measures of the program. Use of a more complex model (i.e. a model that uses routing, such as the HSPF watershed loading model or SWMM) would require monitoring data and/or structural details of stormwater management practices. This level of complexity, in addition to being cost prohibitive, is unnecessary to accomplish the intent of the model to comply with the General Permit.

Some advantages of using the WTM that were identified and discussed with NYSDEC Region 7 and NYSDEC Central Office include the following:

- The model readily accomplishes the permit objective of a comparison between 2008 and 2011 conditions based in part on changes in land use.
- The model is user-friendly, and it will be possible to utilize and update it in the future after the completion of this project to reassess progress with municipal stormwater management programs. Additional runs of the model can be completed for areas where net increases of POCs are indicated, in order to determine practices that can be utilized to eliminate the net increases and evaluate their effectiveness once they are implemented.
- The spreadsheet-based system used by the model will make it relatively easy to compare aspects of MS4 SWMP Plans to the database, evaluate effectiveness, and suggest improvements.
- The model includes not only structural best management practices such as green infrastructure practices described in the NYS Stormwater Management Design Manual, but also other non-structural practices, such as those available through municipal good housekeeping, illicit discharge elimination, and education, as well as any other BMPs identified in the MS4 permit.
- The model allows the pollutant removal efficiencies of practices and compliance efforts to be adjusted if necessary to account for maintenance conditions or degree of implementation.

2.3. WTM Overview

The WTM was developed by the Center for Watershed Protection (Baltimore, Maryland) and is available as a free download at www.cwp.org. As stated in the WTM 2010 User's Guide, "The WTM is a spreadsheet-based model that calculates annual pollutant loads and runoff volumes, and accounts for the benefits of a full suite of stormwater treatment practices and programs." A copy of the WTM 2010 User's Guide is included in Appendix A to this report.

The WTM is an expanded version of the Simple Method. The Simple Method is a stormwater model that calculates pollutant loading through a weighted average of the area of a particular land use multiplied by an assumed loading of pollution from that land use. The WTM's expansion of the Simple Method includes a pollutant removal process that calculates removal by multiplying an inflow of pollutant concentration by an assumed reduction rate for a particular treatment or management process. The WTM also calculates pollutant loading from certain point sources. In general, the WTM functions as follows:

The WTM provides a straightforward approach that is relatively easy to implement. This approach is appropriate given the circumstances, particularly since the goal is to provide a basis for comparison of one set of conditions to another set of conditions.

3. Identification of Study Areas

3.1. Sewershed Delineation

As previously stated, the units modeled were the storm sewersheds draining to each designated impaired water body within each municipal jurisdiction. Since the requirement pertains solely to areas that drain directly to the impaired segments identified, areas within the subwatersheds that do not discharge directly to the identified impaired segments were omitted from the analysis.

Storm sewersheds were delineated using topographic information from FEMA's recent LiDAR surveys. These LiDAR surveys were undertaken as part of FEMA's Map Modernization Program. C&S used both 3-dimensional cadd software and GIS applications to perform these tasks. Field verifications were performed where confirmation of certain features and characteristics were required.

3.2. Urban vs. Non-Urban Areas

This project included areas both within and outside the Syracuse Urbanized Area (SUA). In order to maintain compliance with the General Permit, permitees will need to demonstrate No Net Increase of POCs in each MS4 and in the SUA. In order to provide the most usable data set, the study areas were divided at both municipal and SUA boundaries (as designated by the U.S. Census Bureau - 2000). These divisions will create a framework for the participating municipalities to gauge compliance with the General Permit and, if necessary, develop management policies and provide accurate guidance to their constituents and development project applicants. It should be noted that the General Permit requires that all 6 Minimum Control Measures (MCMs) be applied inside the SUA. Outside the SUA, only MCMs 4 and 5 (Construction Site Stormwater Runoff Control and Post-Construction Stormwater Management) are required.

3.3. Study Areas (Model Units)

Mapping of each of the storm sewersheds are included as Appendix B to this report. The following table contains a list of the model units:

Municipality	Impaired Water Listing	SUA Status
Baldwinsville	Seneca River lower main stem	URBAN
Camillus Town	Harbor Brook lower and tribs	URBAN
Camillus Town	Ninemile Creek, lower and tribs	NON-URBAN
Camillus Town	Ninemile Creek, lower and tribs	URBAN
Camillus Village	Ninemile Creek, lower and tribs	URBAN
Cicero	Ley Creek and tribs	NON-URBAN
Cicero	Ley Creek and tribs	URBAN
Clay	Bloody Brook and tribs	NON-URBAN
Clay	Bloody Brook and tribs	URBAN
Clay	Ley Creek and tribs	URBAN
Clay	Minor tribs to Onondaga Lake	NON-URBAN
Clay	Minor tribs to Onondaga Lake	URBAN
Clay	Seneca River lower main stem	NON-URBAN
Clay	Seneca River lower main stem	URBAN
DeWitt	Ley Creek and tribs	NON-URBAN
DeWitt	Ley Creek and tribs	URBAN
DeWitt	Limestone Creek, lower and minor tribs	NON-URBAN
DeWitt	Limestone Creek, lower and minor tribs	URBAN
East Syracuse	Ley Creek and tribs	URBAN
Fayetteville	Limestone Creek, lower and minor tribs	URBAN
Geddes	Harbor Brook lower and tribs	URBAN
Geddes	Ninemile Creek, lower and tribs	NON-URBAN
Geddes	Ninemile Creek, lower and tribs	URBAN
Geddes	Onondaga Lake, northern end	URBAN
Geddes	Onondaga Lake, southern end	URBAN
Geddes	Seneca River	URBAN
LaFayette	Upper Onondaga Creek and tribs	NON-URBAN
LaFayette	Upper Onondaga Creek and tribs	URBAN
Liverpool	Bloody Brook and tribs	URBAN
Liverpool	Minor tribs to Onondaga Lake	URBAN
Liverpool	Onondaga Lake, northern end	URBAN
Lysander	Seneca River lower main stem	NON-URBAN
Lysander	Seneca River lower main stem	URBAN

Municipality	Impaired Water Listing	SUA Status
Manlius Town	Ley Creek and tribs	NON-URBAN
Manlius Town	Limestone Creek, lower and minor tribs	NON-URBAN
Manlius Town	Limestone Creek, lower and minor tribs	URBAN
Manlius Village	Limestone Creek, lower and minor tribs	URBAN
Marcellus Town	Ninemile Creek, lower and tribs	NON-URBAN
Minoa	Limestone Creek, lower and minor tribs	URBAN
North Syracuse	Ley Creek and tribs	URBAN
Onondaga	Harbor Brook lower and tribs	NON-URBAN
Onondaga	Harbor Brook lower and tribs	URBAN
Onondaga	Middle Onondaga Creek and tribs	NON-URBAN
Onondaga	Middle Onondaga Creek and tribs	URBAN
Onondaga	Ninemile Creek, lower and tribs	URBAN
Onondaga	Upper Onondaga Creek and tribs	NON-URBAN
Onondaga	Upper Onondaga Creek and tribs	URBAN
Pompey	Limestone Creek, lower and minor tribs	NON-URBAN
Pompey	Limestone Creek, lower and minor tribs	URBAN
Salina	Bloody Brook and tribs	URBAN
Salina	Ley Creek and tribs	URBAN
Salina	Onondaga Lake, northern end	URBAN
Salina	Onondaga Lake, southern end	URBAN
Salina	Seneca River lower main stem	URBAN
Salina	Minor tribs to Onondaga Lake	URBAN
Solvay	Harbor Brook lower and tribs	URBAN
Solvay	Minor tribs to Onondaga Lake	URBAN
Syracuse	Harbor Brook lower and tribs	URBAN
Syracuse	Ley Creek and tribs	URBAN
Syracuse	Lower Onondaga Creek and tribs	URBAN
Syracuse	Onondaga Lake, southern end	URBAN
Van Buren	Ninemile Creek lower and tribs	NON-URBAN
Van Buren	Onondaga Lake, northern end	NON-URBAN
Van Buren	Seneca River lower main stem	NON-URBAN
Van Buren	Seneca River lower main stem	URBAN

4. Discussion of Model Application

4.1. WTM Input Variables

Much of the following information is taken directly from the WTM 2010 User's Guide. A copy of which is included as Appendix A to this report. The WTM input variables are divided into several sections. The sections used for this project include "Primary Sources", "Secondary Sources", and "Existing Management Practices". A detailed breakdown of the individual input variables, including data sources, assumptions, and notes, is included in Appendix C to this report. The following paragraphs contain a general discussion of the different sections of input variables.

The *Primary Sources* worksheet summarizes the loads from sources that can be determined solely by land use. It requires basic land use information and calculates surface runoff loads. In addition, it requires basic watershed data, such as annual rainfall, stream length, and soils distribution. The loads calculated in this worksheet incorporate data from the "turf management" section of the "existing management practices" tab (see page 6 of the WTM 2010 User's Guide), and model default values reflect typical lawn care practices.

The *Secondary Sources* worksheet contains variables for pollutant sources that cannot be calculated based on land use information alone. Many of these sources, such as CSOs and SSOs, are at least partially composed of sanitary wastewater.

The *Existing Management Practices* worksheet reflects programs currently in place to control loads from urban land. Users need to input information about the effectiveness and level of implementation of various programs and practices. This sheet, and other sheets in the WTM that quantify program implementation, ask the user to input "discount factors" for each practice. "Discount factors" are used to reduce the ideal (i.e., literature value) load reductions for a practice that can rarely be achieved. For example, structural practices may lack space or have poor maintenance that can hamper practice effectiveness over time. For programmatic practices, such as lawn care education, only a fraction of the population may implement the recommendations put forward in the educational program. In both of these cases, specific design features for structural practices, or marketing approaches for education and outreach techniques can make the practice more effective. While some discount factors have default values, the WTM asks the user to input values for others. In each case, the model provides guidance to select appropriate values.

4.2. Land-use Identification Technique

In the WTM, the land-use variable can have a substantial influence on the pollutant loading results. C&S prepared GIS land use data within the study area using aerial photography. Aerial photography provides the clearest, most accurate depiction of surface conditions. Automatic feature extraction and classification software was used to create electronic land use information sets from aerial photography. This software reads an aerial photograph, analyzes the photograph, assigns land-use categories, and produces GIS shapefiles as output.

For both 2008 and 2011, USDA National Agriculture Imagery Program (NAIP) aerial photography was analyzed:

- For 2008, 3-Band Natural color county mosaic (Image date varies from May 2008 to July 2008; Published date: Nov 2008)
- For 2011, 3-Band Natural color county mosaic (Source: Image date varies from May 2011 to July 2011; Published date: Nov 2011) and 4-Band Quarter Quad (Source: Image date varies from May 2011 to July 2011; Published date: Nov 2011)

The land-use categories in the standard WTM can be considered in two categories: "developed" areas and "non-developed" areas. The developed areas include residential (with four subcategories), commercial, industrial, and roadway. The non-developed areas include forest, rural, and open water. The water quality calculations within the WTM are driven by assumed impervious and turf covers within each the developed categories. In the WTM, the phosphorus loading rates are based directly on the percentage of turf cover and the event mean concentration. In most stormwater modeling programs, impervious/turf coverage balance is one of the most important factors that affect the result. There is a growing body of literature and a growing general belief that the percentage of impervious coverage in a watershed will have a direct result on the rate and quality of stormwater runoff.

The project stakeholders determined that it would be more accurate and more relevant to calculate the actual impervious areas within the developed categories. Recent advances in aerial imagery analysis software have allowed for accurate identification of impervious surfaces. This approach avoided the inaccuracies inherent with the following steps, which were no longer required:

- The assignment of each developed portion of land to one of the developed categories
- The assumption of an impervious coverage for each developed portion of land

The land use classifications process was as follows:

1. Classify individual portions of the study area as “non-developed” or “developed”
2. Within the “non-developed” areas, classify the land uses as “roadway”, “forest”, “rural, or “open water”.
3. Within the “developed” areas, classify the land uses as “impervious” or “pervious” – within the “developed” areas, pervious surfaces will be treated as lawns in the model.

The project stakeholders believe that this approach will provide a more useful database of information for municipalities as they continue to try to meet the requirements of stormwater-related regulations. We note that if municipalities update their WTM models in the future to reflect land-use change, the change in classification should be fairly straightforward, whether it is done manually or electronically.

4.3. Fecal Coliform Loading Rate Modification

The project stakeholders questioned whether the WTM's default loading rate for fecal coliform (20,000 MPN/100 mL) is realistic and appropriate for the study area. After comparing it with several other available studies and examining preliminary results of the model, there was concern that this value is too high. The project stakeholders examined available literature to determine which estimated concentration for fecal coliform would be best. Literature sources included the EPA publication "Effluent Guidelines for the Construction Industry", the National Stormwater Quality Database Progress Report by the University of Alabama and Center for Watershed Protection, and the EPA's Nationwide Urban runoff Program (NURP). Following a review of the literature, the fecal coliform event mean concentration for developed land uses was changed from 20,000 MPN/100 mL to 1800 MPN/100 mL. This value is approximately in the middle of the range of published data.

4.4. Pet Waste Education Variable

The Pet Waste Education variable contains an "Awareness of Message" factor. This factor can be set at varying values depending on the assumed public awareness of a municipality's pet waste management program. This factor is a direct multiplier of the pollutant loading calculated from pet waste. As an example, if the Awareness of Message factor was set at 30%, the pollutant loading from pet waste would be reduced by 30%. The WTM contains guidance for the selection of this factor. Examples of such guidance include a suggested factor of 30% if education about a municipality's pet waste program was done through newspaper and 8% if the municipality had produced a brochure.

Under certain assumptions, it was noted that the benefit of pet waste education efforts was extreme and out of proportion with the existing fecal coliform loading levels. It was recognized that with a change in Awareness of Message from 2008 to 2011 of 8% to 30% the fecal coliform loading from developed land uses was reduced dramatically. It was believed that this dramatic reduction was unrealistic to expect from a change in the advertising medium for a pet waste policy. Consequently, the pet waste variables were adjusted; an Awareness of Message factor of

5% was used for 2008 and 8% for 2011. Following this change, the results seemed more reasonable.

4.5. CSO Variable

The CSO variable is located on the "Secondary Sources" tab of the WTM. Section III.B. of the General Permit requires that "covered entities periodically evaluate their StormWater Management Plan (SWMP). MS4s are required to demonstrate that there are No Net Increases in discharge of stormwater POCs to the impaired waters for *storm sewersheds*…". The NYSDEC definition of storm sewershed is *the catchment area that drains into the storm sewer system based on the surface topography in the area served by the stormsewer*. Because an area contributing to a CSO is not a storm sewershed, the CSO function of the WTM was not used. Areas designated as tributary to CSO systems were not modeled as part of this project.

4.6. Assumptions for Various WTM Variables

The WTM contains several input variables for which data was either not available, limited, or not realistic to evaluate. In some cases, values for these variables were assumed. In other cases, these variables were effectively eliminated from the model. In some cases where variables were effectively eliminated from the model, these variables were outside of the control of the municipality or not relevant to the municipality's compliance with the General Permit. For some of the WTM variables, there was no reason to believe that any directed or systemic change had occurred between 2008 and 2011. Because the WTM is being used as a comparative rather than an absolute model, the "elimination" of these variables is acceptable. As MS4s use the WTM to demonstrate compliance with the General Permit, the MS4s should modify and use these variables if better or more complete information is available.

A complete identification of all variables and their data sources and assumptions is included as Appendix C to this report. A select group of variables and their treatments are listed below.

On the "Secondary Sources" tab:

- Percentage of septic systems less than 100 feet from a waterway (assumed 2%)
- Fraction of watershed population (dwelling units) illicitly connected (assumed 0.1%)

  Onondaga County has found very few illicit discharges in dry-weather investigations of over 1000 outfalls)

- Number of businesses in the municipality (assumed 2)

  The number generally refers to businesses with potential for illicit connections, such as car washes or dry cleaners

- Fraction of businesses illicitly connected (0.1%)

On the "Existing Management Practices" tab:

- Percent of lawns bare or compacted (10%)
- Percent of lawns highly managed (10%)
- Erosion and sediment control installation and maintenance discount (Assumed 0.75

  The WTM suggested values between 0.6 and 0.9)

- Percentage of impervious connected to closed drainage (assumed 20% for non-urban sewersheds, assumed 50% for urban sewersheds)

4.7. Other Modifications to WTM

Additional minor modifications were made to the WTM spreadsheets. These modifications are identified in the following paragraphs.

As part of this project, the CNY RPDB collected certain data from municipalities. At the time of this data collection, the boundaries of the individual model units had not been delineated. It is believed that each municipality reported this data relative to their entire municipal boundary. In many cases, the delineated model units did not contain entire municipalities. In all cases, the reported data was applied to the delineated model unit(s) within the municipality. As an example, if a municipality reported that 100 catch basins were cleaned, it was assumed that each of the 100 catch basins were located inside a delineated model unit. If that same municipality contained 5 model units, it was assumed that 20 catch basins were cleaned in each of the 5 model units. Thus the percentage of catch basins cleaned (and the fraction of the total "treated" connected impervious area) for the municipality is constant in each model unit in that municipality. This principal was applied to both catch basin cleaning and street sweeping.

For catch basin cleaning data, a set of cells was added to each individual WTM model on the "Existing Management Practices" tab to the right of the "Catch Basin Cleanout" section. This additional set of cells contains input cells for the number of catch basins that exist in the municipality, the number of catch basins that were cleaned in the municipality, and the number of delineated model units in the municipality. As the WTM is further developed, and as data is more accurately maintained, the original input cells could be used.

For street sweeping data, a set of cells was created on the municipal "Summary" sheet. This municipal Summary sheet is a separate excel file that was originally created to calculate the overall pollutant loading for each municipality and to show the changes from 2008 to 2011 in that municipality. This set of cells contains entry cells for street sweeping quantities as well as entry cells for the area of the entire municipality and the average width of roads. All of this information is used to automatically populate the corresponding cells in the "Street Sweeping" section of the WTM on the "Existing Management Practices" tab. As the WTM is further developed, and as data is more accurately maintained, the original input cells could be used in the individual WTM files. It is noted that the municipal "Summary" sheet is not likely to be used in the demonstration of compliance with the General Permit.

The standard version of the WTM includes an input variable "% of Homes <10 Years Old" in the "Turf Condition and Management Practices – Residential" section of the "Existing Management Practices" tab. This section of the WTM calculates pollutant loading resulting from assumed applications of lawn fertilizer. The WTM uses a 10-year old home as a bench mark based on the assumption that "younger" lawns will be fertilized at higher rates. The project stakeholders believed that it would be more realistic to expect that higher rates of fertilization might occur for 2 years rather than 10 years. A 2-year increased fertilization rate is also more consistent with the latest New York state law regulating application of lawn fertilizer. This law states that phosphorus-containing fertilizer can only be used when establishing new lawns.

It should also be noted that within the "developed" land use category that was modified from the original version of the WTM, all turf land uses are assumed to provide the same pollutant loading. The turf pollutant loading would have remained the same if the WTM's original land use categories had been used, provided that the standard WTM loading settings were used.

4.8. Project Deliverables

C&S has provided the completed modeling program to the CNY RPDB as follows:

- ✓ Reporting – a short report was prepared that describes:
  - sources of data for input into the model
  - additions and/or modifications to the basic model structure
  - recommendations for future maintenance of the modeling program

- ✓ Modeling – the modeling will be delivered in the original excel format that can be easily modified as part of future analyses. An excel model file has been prepared for each modeled unit. Modeled units are organized by watercourse segment, SUA (in or out), and municipality. The models are included in Appendix D.

- ✓ GIS – files have been provided containing watershed boundaries and land use classifications. Any updates to storm sewer outfall mapping done as part of the project will be provided to the CNY RPDB and the appropriate municipality.

- ✓ Mapping – Color drawings have been prepared for each municipality. These drawings depict watercourse segments, storm sewershed boundaries, municipal boundaries, and locations of stormwater management facilities.

5. Considerations for Continuing Model Application

The WTM was chosen as a tool for this project, in part, due to the potential for future updates to be made with minimal effort and expense. This work may be able to be performed by a municipal employee that possesses good technical and organizational skills. For municipalities that do not experience substantial development, this approach may be manageable. For a small number of instances of land-use change, the effort to maintain a reasonably accurate WTM should not be overwhelming. Before a similar approach is undertaken by a municipality, it is suggested that the municipality discuss this intent with the applicable regulators. This will increase the likelihood that the municipality is able to deliver adequate information at an acceptable level of accuracy.

While the "do-it-yourself" approach may be feasible and cost-effective for some municipalities, a few key disadvantages should be considered. Over time, using a more manual approach, the high quality data (particularly the land-use data) that has been prepared by the CNY RPDB will be less applicable. Also, when the municipal employee responsible for updating the modeling and reporting no longer works in their position, other personnel will need to be trained. In addition, manual updates to land use data may not capture changes that can occur without municipal approval, such as forest clearing or the transition of an agricultural area to a forest.

5.1. Land-Use Updates

As previously stated, the land use classifications were determined using a GIS-based analysis of aerial photography. While this analysis was performed by GIS experts, future updates to the land-use variable of the WTM could be performed without using GIS. Because the land use classifications for each model unit have been established as part of this project, updates would only be needed where land-uses have changed. This could be undertaken using simple arithmetic.

As an example, if 3 acres of forest were converted into a commercial site with 1 acre of pavement and 2 acres of lawn, the appropriate land use categories could be modified in the latest version of the WTM. Presuming that a stormwater management facility was constructed as part of this project, the corresponding data could be entered into the Existing Management Practices tab. If other changes to land use were involved with the project, such as an extension of a public sewer, the creation of a new roadway, or the addition of a septic system, these changes should be reflected in the latest version of the WTM.

While this approach would result in a modest cost to municipalities, it does present some disadvantages. The results of this analysis have been recorded in GIS shapefiles. These GIS shapefiles are valuable data sets that can be used for several planning, regulatory, and management purposes. Using the manual process of updating land use described above, these GIS shapefiles will no longer be accurate. While they could be updated relatively easily at any point in the future, they would not be particularly useful during periods in which their information is obsolete.

5.2. On-Site Sewage Disposal Systems

The Secondary Sources tab of the WTM contains the "On-Site Sewage Disposal Systems" section. This section contains the input cells and performs the loading calculations for this pollutant loading source. It is believed that the parameters in the WTM are set to reflect older, less effective septic systems. With increased performance standards and increased supervision of installation, the septic systems installed today are more effective than their older counterparts. Some older systems in Onondaga County were not designed to any standards at all.

The majority of new dwelling units in Onondaga County are served by public sewers. However, the installation of a new house with a septic system may result in an unrealistic increase in pollutant loading under the current model arrangement. It is recommended that future versions of the WTM be modified to include a mechanism to reflect this difference in performance. A new section of the model could be created as a copy of the original, with parameters adjusted accordingly.

5.3. Tax Record Updates

As the WTMs were prepared as part of this project, several input data were taken from Onondaga County tax records. These data included the number of residential units, the number of unsewered dwelling units, and the number of homes less than 2 years old. These tax searches were performed using GIS queries of the electronic tax files. This data could be updated relatively easily using manual methods, provided that the municipality keeps suitable records of this information. If a more automated approach is taken, the user is encouraged to ensure that the search of the tax records is performed following an update of those tax records.

5.4. Maintenance and Pollutant Loading Results

The WTM has the capability to calculate pollutant loading benefits that result from several maintenance and management practices, including turf management, catch basin cleaning, street sweeping, and others. These items are generally included on the Existing Management Practices tab of the WTM. Over the course of this project, it was noticed that several model units showed very small pollutant loading increases from 2008 to 2011. It was also noticed that a relatively modest increase in certain maintenance practices could provide a large enough benefit to show an overall loading reduction. As WTMs are updated in the future, municipalities are encouraged to keep accurate records of maintenance and management practices and use these practices to remain compliant.

The implementation of the models also demonstrated a potential shortcoming of the consideration of maintenance practices. Not all maintenance frequencies will correspond well to the presumed annual reporting and modeling cycle. As a small-scale example, a catch basin with a very small, mostly vegetated contributing drainage area may only need to be cleaned once every few years. During the year in which this catch basin is cleaned, the model will show an associated decrease in pollutant loading. If the catch basin is not cleaned during the following year, the model will show an associated increase in pollutant loading. If all other elements in the model remain unchanged, the municipality could be viewed as being non-compliant. The project stakeholders discussed the possibility that a "running average" approach to pollutant modeling, possibly over 3 to 5 years, might be a mitigative approach, but that this could be complex and would require discussion with regulators. The best approach to avoiding this type of modeling inconsistency may be for the municipality to conduct maintenance on a more formulaic schedule.

5.5. Phased or Extended Duration Land Development

As the models were developed for this project, examinations of the results identified an issue that could affect a municipality's ability to comply with the permit. This project included the creation of models for the years 2008 and 2011. The economic downturn of 2008 likely contributed to the slow pace of home construction in Onondaga County. This could be seen in the atypically slow "build-out" of several residential development projects in certain model units.

In a common phasing plan for a multi-unit development project, shared stormwater management areas are installed prior to the development of individual lots, parcels, or outbuildings. If the complete build-out of this project occurs over more than one modeling cycle, the calculated pollutant loading will be affected. If a model is created during the time that land use data shows a new stormwater management facility and no other associated land development, then a large pollutant loading benefit will be shown. If the next modeling cycle contained full or even partial build-out of the project, then the model will show an increase in pollutant loading over the previous period (barring any other changes to the model). While this would be an accurate application of the model, it does not seem to reflect the intent of the General Permit requirement.

After some discussion, the project stakeholders chose to present the models based on the actual land use classification. The manipulation of the data to try to account for this inconsistency did not seem reasonable. If a stormwater management facility was constructed without any associated development, then the benefit of this facility was included in the model. As a result, the models for areas in similar circumstances will show pollutant loading increases that are not necessarily reflective of the longer term management of these areas. While the final logistics of reporting a municipality's demonstration of compliance have not yet been arranged, it is assumed that a venue for dialogue with regulators will be available. It is with such a dialogue that this particular inability of modeling, and others that will likely arise, can be identified and discussed.

5.6. Cooperation with Non-Traditional MS4s

Most MS4s contain non-traditional MS4s inside their boundaries, including school districts, hospitals, transportation authorities, and other government agencies. Many of these non-traditional MS4s are not strictly required to participate in the complete project approval processes of the local MS4s. While notification and signatory requirements are in place, they are occasionally not vigorously enforced. As the requirement to demonstrate "no net increase" in pollutant loading is enforced, it will be important for municipalities to be aware of the development projects of non-traditional MS4s and ensure that the stormwater management practices are properly designed, constructed, and maintained.

5.7. Onondaga County General Permit Compliance

Onondaga County, as an equal and contributing grant partner, intends to use the WTMs created as part of this project to demonstrate their compliance with the General Permit. Due to the situation whereby Onondaga County facilities are physically located within the boundaries of other regulated cities, towns and villages, this will require communication between the County and the municipalities as models are updated. As the County undertakes development projects on its property, the design information (area of project, prior land use, current land use including impervious area, stormwater management facilities, etc) should be provided to the municipality for inclusion in their updated WTM. In turn, the municipalities should provide copies of their updated WTMs to the County. It is likely that the County will combine the various models for the respective watercourses and present this information to demonstrate their compliance with the permit.

It is noted that this communication path is new and may require certain adjustments to typical procedures to become established. While this will likely require additional efforts in the short term, a more organized approach to stormwater management should result in benefits to water quality in Onondaga County.

5.8. Potential Frequency, Reporting Methods

As of this writing, the details of the procedure for demonstrating compliance with the permit are not known. It would be reasonable to assume that a portion of a municipalities MS4 report would be dedicated to discussion of the "no net increase" requirement of permit. The results of the WTM modeling could be identified and discussed. The actual models could be attached as an appendix to the report.

APPENDIX A

Watershed Treatment Model (WTM)
2010 User's Guide

Funding Provided By:
US EPA Office of Wetlands Oceans and Watersheds
Altria Foundation
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Environmental Technology

June, 2010

Deb Caraco, P.E.
Center for Watershed Protection, Inc.

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USE OF THE GUIDE

This Guide provides guidance to users of the Watershed Treatment Model 2010 Version. This document is designed to assist the user with data entry and interpretation. The model documentation is in preparation and will be available as a separate document.

The WTM 2010 is constantly being updated based on input from users. If you have any questions or comments, please feel free to contact Deb Caraco at the Center for Watershed Protection (dsc@cwp.org). Your comments will allow us to continuously improve the WTM.

ACKNOWLEDGEMENTS

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Watershed Treatment Model (WTM) 2010 User's Guide

The WTM is a spreadsheet-based model that calculates annual pollutant loads and runoff volumes, and accounts for the benefits of a full suite of stormwater treatment practices and programs. This document provides an introduction to the WTM, as well as tips and instructions for using it.

SECTION 1. MODEL STRUCTURE AND OVERVIEW

The WTM completes modeling in three steps: 1. Calculating Existing Pollutant Loads; 2. Calculating Loads with "Future" (i.e., planned) Management Practices; and 3.Accounting for Future Growth (Figure 1). The results of each of these modeling phases are reported in the purple worksheets. The purple worksheets summarize the calculations completed in the green calculation sheets. In total, the WTM includes ten separate worksheets. These worksheets are summarized in this section, and presented in more detail in the remainder of this guide.

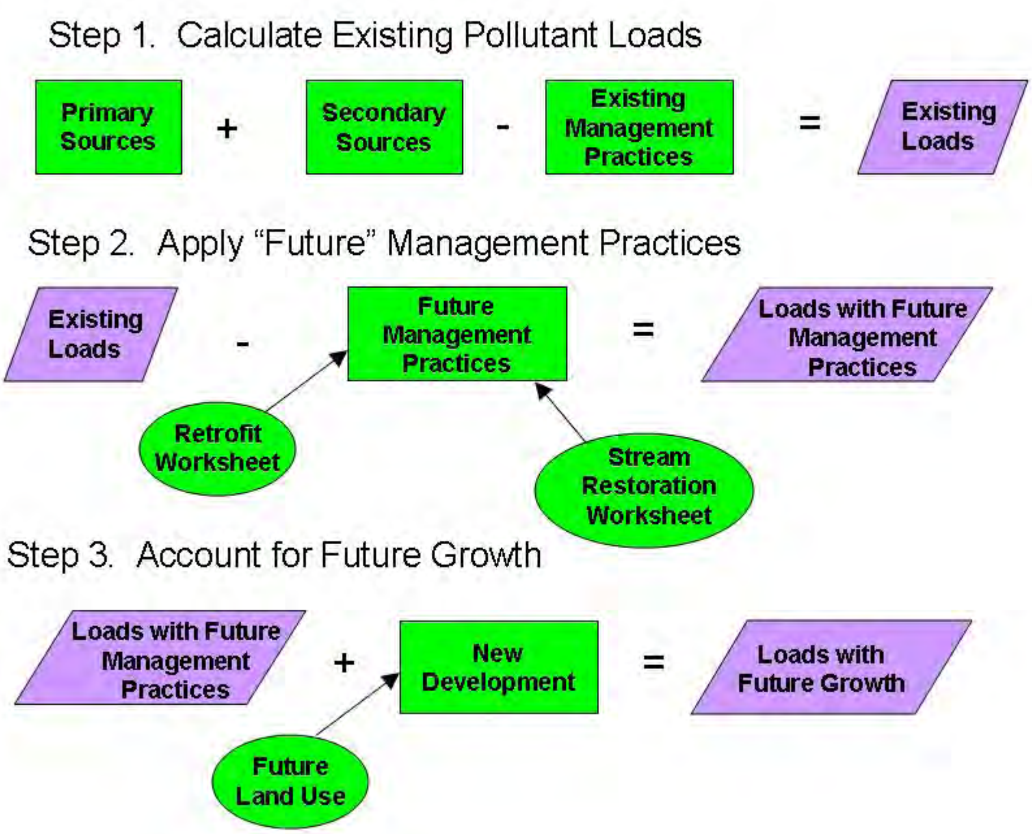

Figure 1. WTM Model Structure

Primary Sources

This worksheet summarizes the loads from sources that can be determined solely by land use. It requires basic land use information and calculates surface runoff loads. In addition, it requires basic watershed data, such as annual rainfall, stream length, and soils distribution. The loads calculated in this worksheet incorporate data from the "turf management" section of the "existing management practices" tab (see page 6), and model default values reflect typical lawn care practices.

Secondary Sources

Secondary sources are pollutant sources that cannot be calculated based on land use information alone. Many of these sources, such as CSOs and SSOs, are at least partially composed of wastewater.

Existing Management Practices

This sheet reflects programs currently in place to control loads from urban land. Users need to input information about the effectiveness and level of implementation of various programs and practices.

This sheet, and other sheets in the WTM that quantify program implementation, ask the user to input "discount factors" for each practice. "Discount factors" are used to reduce the ideal (i.e., literature value) load reductions for a practice that can rarely be achieved. For example, structural practices may lack space or have poor maintenance that can hamper practice effectiveness over time. For programmatic practices, such as lawn care education, only a fraction of the population may implement the recommendations put forward in the educational program. In both of these cases, specific design features for structural practices, or marketing approaches for education and outreach techniques can make the practice more effective. While some discount factors have default values, the WTM asks the user to input values for others. In each case, the model provides guidance to select appropriate values.

Future Management Practices

This sheet reflects the planned extent of programs to control loads from urban land. By default, the model populates this sheet with values from the "Existing Management Practices" sheet. The user then enters data that describe proposed or "future" management practices given the same existing land use.

Retrofit Worksheet

Stormwater retrofits are BMP put in place after development has occurred. The retrofit worksheet allows the user to input individual stormwater retrofit practices. These are then reported in the "Future Management Practices" sheet.

Future Land Use

In this sheet, the user enters the projected future land use in the watershed. Land use can be determined from comprehensive planning or zoning documents, or forecasted using other methods. If no data are entered in this tab, the model default is to assume no growth in the watershed.

New Development

This sheet calculates the loads from future development, based on future development in the watershed, and proposed future treatment. The sheet calculates new "primary source" loadings based on the increase in area of certain land uses, then asks the user to describe the types of stormwater controls on new development. Next, it adds secondary sources, such as loads from new septic customers and wastewater treatment plant loads. Finally, it calculates the loads from active construction as land is developed.

Display Sheets

Three sheets display final loads and runoff volumes: *Existing Loads, Loads with Future Practices*, *Loads Including Growth*. These sheets simply sum up the loading from other sheets, and partition them into surface (both storm- and non-storm) and groundwater loads.

SECTION 2. DATA ENTRY OVERVIEW

Although the WTM is a simple model, it requires significant data input. In addition, no part of the spreadsheet is write protected, in order to allow for maximum flexibility. These decisions put a great deal of responsibility on the user, and some guidelines need to be followed to prevent errors in algorithms. This section describes some components of the WTM designed to facilitate the data input process, as well as some tips for tracking down and avoiding errors in the model.

Color Coding

In order to make data entry easier, cells are coded in four colors: green, blue, grey and purple.

GREEN CELLS must be filled out, unless a pollutant source or treatment option is not being considered. For example, the acres of commercial land only need to be filled out only if commercial land is in the watershed.

BLUE CELLS represent model defaults that a user may want to modify. Examples include pollutant concentrations and practice efficiencies.

GREY CELLS have been calculated, and typically should not be overridden. Examples include practice load reductions.

PURPLE CELLS represent "bottom line" calculations, such as load reductions or final loads.

The worksheets of the WTM are also color coded. Of the ten tabs of the WTM, three are strictly for output, and have a purple tab color, while the remainder are green to indicate that data entry is needed.

"Pop-Up" Guidance and Comments

Many pieces of input data require some judgment on the part of the user. By clicking on many of the green cells (particularly those for discount factors), a "popup" message will appear with guidance for data values (Figure 2).

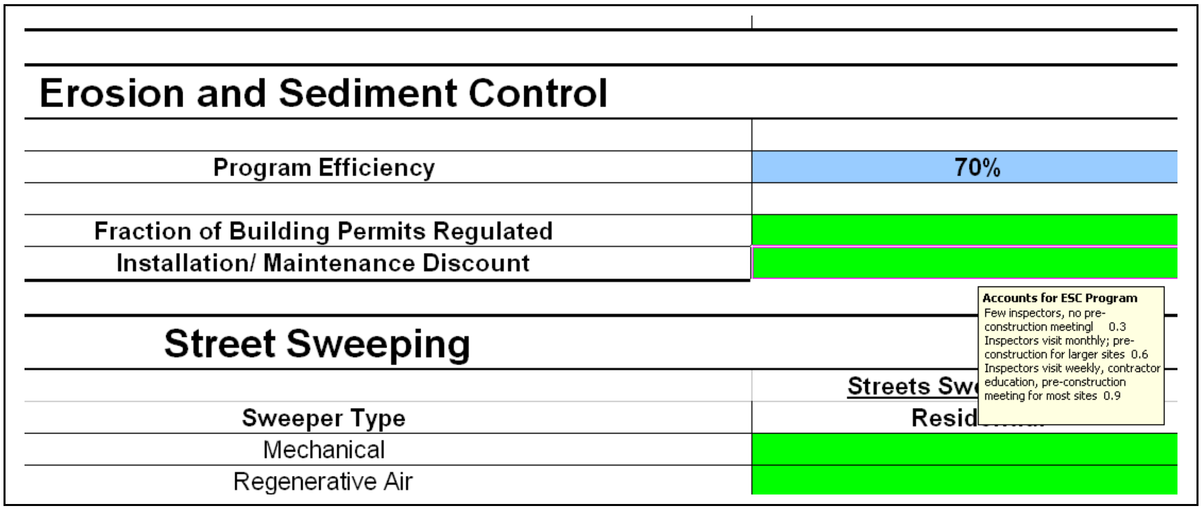

Figure 2. Example Pop-Up Guidance for the Installation/Maintenance Discount for ESC programs

Pull-Down Menus

While many of the data in the WTM require a number value, some of the inputs are multiple choice (e.g., type of practice) or "yes/no" (e.g., Do you have a program for…") questions. The WTM uses "pull down menus" for these questions. For these cells, the user should not (and cannot) select an option that does not appear in the menu.

Changing Cell Colors and "Enter Value" Notes

For some practices, the need for data is conditional on another input parameter. For example, information about the effectiveness of pet waste programs is needed only if the user answers "yes" to the question "Program in Place?" (Figure 3). Users need to enter a value in these cells.

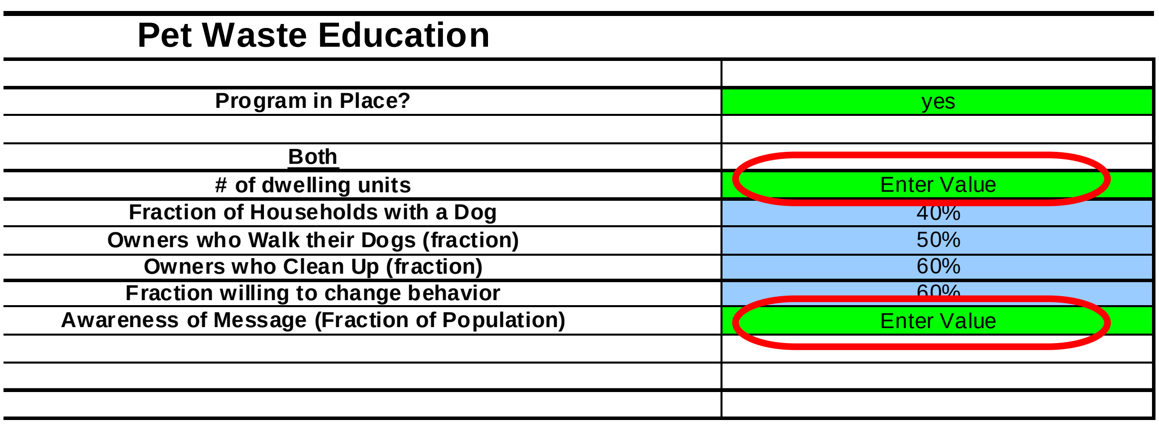

Figure 3. Example "Enter Value" (circled on this figure) cells for pet waste education. These cells appear when "yes" is selected for the "Program in Place" value.

Tracking Down Errors

There are two errors a user may encounter in the WTM that are based on incomplete data entry. A "DIV/0" error usually results when a key item on the "Primary Sources" tab of the model, such as annual rainfall or stream length is not entered. A "#Value!" error will typically be returned if the user does not enter a needed value to describe a program. If this value appears, try looking for cells that say "Enter Value." Entering the needed value in this cell will avoid this error.

SECTION 3. DATA ENTRY DETAILS

This section describes in detail the data entry requirements of each worksheet of the WTM. It separates the discussion by worksheet (for each calculation sheet), but "Existing Management Practices" and "Future Management Practices" are discussed together because of the overlap between the two.

Primary Sources

This worksheet has four major sections: *Land Use*, *Partitioning Coefficients for Rural and Forest Land, Watershed Data,* and *Soils Information*. Data Requirements for each are as follows:

Land Use

The user is required to enter the area of each land use category. If there is a land use that is not in included the model but it is present in the watershed, the user should type in the land use category (Figure 4) and enter in appropriate values to characterize the land use in the blue cells listed below. In addition, users may override model defaults for land uses included in the model for the following data (blue cells):

- Impervious Cover %
- Turf %
- Pollutant Concentrations
- Pollutant Loading rates/Runoff Rates (lbs/acre, billion/acre or in/year). Note that, for rural and agricultural land uses, loading rates should be entered directly, since they are not determined from concentrations and runoff calculations for these land uses.

PRIMARY SOURCES - Land Use Watershed					Concentrations		
		Area (Acres)	Impervious Cover (%)	Turf Cover (%)	TN (mg/l)	TP (mg/l)	TSS (mg/l)
Category	Detailed Description						
Residential	LDR (<1du/acre)		12%	70%	2	0.26	55
	MDR (1-4 du/acre)		21%	63%	2	0.26	55
	HDR (>4 du/acre)		33%	54%	2	0.26	55
	Multifamily		44%	45%	2	0.26	55
				0%	2	0.26	55
				0%	2	0.26	55
				0%	2	0.26	55
				0%	2	0.26	55
				0%	2	0.26	55
				0%	2	0.26	55
Commercial	Commercial		72%	22%	2	0.26	55
				0%	2.0	0.26	55
				0%	2.0	0.26	55
				0%	2.0	0.26	55
				0%	2.0	0.26	55
Roadway	Roadway		80%	16%	2	0.26	55
				0%	2.0	0.26	55
				0%	2.0	0.26	55
				0%	2.0	0.26	55
				0%	2.0	0.26	55
Industrial	Industrial		53%	38%	2	0.26	55
				0%	2	0.26	55
				0%	2	0.26	55
				0%	2	0.26	55
				0%	2	0.26	55
Forest	Forest						

Figure 4. Land Use Data in the Primary Sources tab. The user needs to enter land areas (green) and may override turf and impervious cover, and pollutant concentration values.

Partitioning Coefficients for Rural and Forest Land

This section includes model defaults determining the fraction of the load from forest and rural land that occurs during storm events, versus as extended baseflow. These can be overridden if better information is available for your watershed.

Watershed Data

This section requires entry for annual rainfall and total stream length. The WTM will return errors if these values are not entered.

Soils Information

This section asks the user to describe the soils in terms of Hydrologic Soils Group (A, B, C or D) by entering the percent of the watershed soils in each category. It also asks the user to enter the break-down of soil type based on depth to groundwater (again, describing the percent of the watershed in each category).

Model defaults in this section include runoff coefficients for each land cover category (Turf, Forest, and Rural). For other land covers, the user may enter runoff coefficients in the green cells (columns I through M). Note that the runoff coefficient for turf also takes into account information provided in the *Turf Management* practice on the "Existing Management Practices" sheet.

Secondary Sources

The secondary sources worksheet sums the loads from sources that cannot be determined by land use alone, such as channel erosion or illicit discharges. The data sheet is structured so that data are entered in smaller tables, or sections of the sheet. With the exception of the general sewage use data and channel nutrient concentration provided at the top of the sheet, each section corresponds to a specific secondary source. The required data for this sheet is summarized in Table 1.

TABLE 1. SECONDARY SOURCE DATA REQUIREMENTS

Source or Data Area	Required Data (Green Cells)	Model Default Data (Blue Cells)	Notes
General Sewage Use Data	Number of single-family, detached dwelling units	• Individuals/unit • Water use/individual • Wastewater pollutant concentrations	These data are needed to compute loads from OSDSs, SSOs, CSOs, Illicit Connections
Nutrient Concentrations in Stream Channels	Concentrations	Enrichment Factor	Figure 5 provides one source for these data. Used in combination with Channel Erosion data to calculate the nutrient loads from channel erosion.
On-Site Sewage Disposal Systems (OSDSs)	• % of Dwelling Units Unsewered • % of Septic Systems <100’ from waterway • Soils for septic systems (from pull-down menu) • System type (% of each type of system) • Description of Management (inspection and maintenance) from pull-down menu • Separation distance from groundwater • Density (#/acre)	• Failure rates (calculated from other factors) • Decay of bacteria (% reaching the surface waterway) • Delivery ratio for nutrients • Efficiencies for each OSDS type	Required data are often available from the health department or other agency responsible for septic system management. If the user enters “other” for a system type, the efficiency ***must*** be entered.

TABLE 1. SECONDARY SOURCE DATA REQUIREMENTS

Source or Data Area	Required Data (Green Cells)	Model Default Data (Blue Cells)	Notes
SSOs	• Miles of sanitary sewer	• Overflows/1,000 miles • Volume per overflow • Fraction of load as storm flow (to partition between storm and non-storm loads)	These sections are a broad estimate of diffuse wastewater sources. If available (e.g., from an SSO/CSO or IDDE study) these data may be directly entered in the Summary table (purple cells) at the bottom of the Secondary Sources worksheet.
CSOs	• Median storm event (inches) • Sewershed area (acres) • Sewershed Impervious Cover (%)	• # CSOs/year (calculated) • Capacity of CS System (rainfall depth in inches) • CSO pollutant concentrations.	
Illicit Connections	• Fraction of watershed population illicitly connected • Number of businesses	• Fraction of businesses with illicit connections. • Characterization of businesses wash water • Business wastewater flow in gpd.	
Urban Channel Erosion	Method of calculation (Methods 1-3) from pull-down menu. All data inputs described are required data. **Method 1. Estimate based on typical estimates:** General Assessment of Channel Erosion (Low, Medium, High) **Method 2. Back calculate based on known sediment loading.** Total watershed loading (lbs TSS/year) based on monitoring data. **Method 3. Estimate based on other study results.** Sediment Load from Channel Erosion (tons/year)		The WTM offers three options for calculating urban channel erosion. Data required varies depending on the method used. Each method requires progressively more data, and provides a more accurate representation of the watershed.

TABLE 1. SECONDARY SOURCE DATA REQUIREMENTS			
Source or Data Area	**Required Data (Green Cells)**	**Model Default Data (Blue Cells)**	**Notes**
Livestock	# of animals in each category	• % of animals exposed to runoff • Load (lbs/animal/year or billion/animal/year) • Delivery ratios of nutrients and bacteria	
Marinas	• Berths • Length of season (days)	• Occupancy (fraction of the season) • Flow rates (gallons/capita/day) • Individuals/boat	This "untreated" estimate can be significantly lowered by the "marina pumpout station" practice in Existing Management Practices.
Road Sanding	• Sand application (lbs/year) • Fraction of roads open section	• Delivery ratio (sand to the receiving water) for closed section roads. • Delivery ratio for open section roads.	This untreated estimate can be partially remedied by street sweeping.
Non-Stormwater Point Sources	• Flow (Millions of gallons/day) • Concentrations (mg/l or MPN/100 ml)	• Loads (lbs/year or billion/year)	Data can be gathered from Discharge Monitoring Reports (DMRs) for NPDES discharges

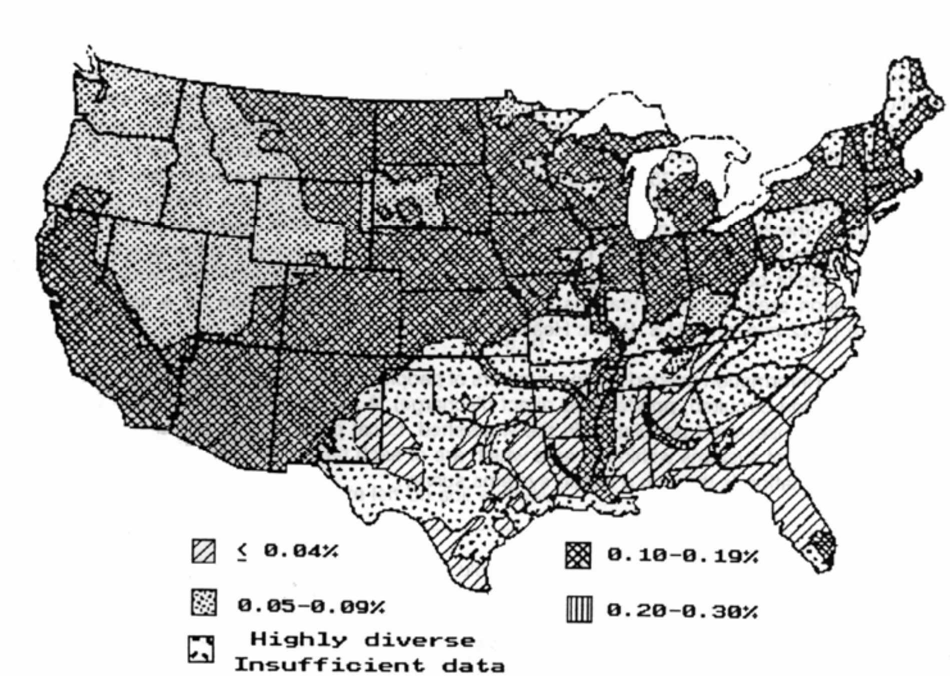

Figure 5. Soil N/P concentrations (by % mass in soil). From Haith et al., 1992

Existing and Future Management Practices
These two worksheets calculate the benefits of practices and programs in the watershed. Current land use conditions are used for the Existing and Future Management Practices worksheet (e.g. does not consider future changes in land use within the watershed). The practices entered into the Existing Management Practices worksheet are carried over to the Future Management Practices. However, additional practices and program options for non-structural practices are included in the "Future Management Practices" section. A description of the practice types and their data input is provided in Table 2. While the specific data for each practice varies, some of the discount factors appear for several practices, including the following:

- **Awareness Factor:** Applied to all educational programs, the awareness factor reflects the % of people who remember an educational message.
- **Maintenance Factor:** Typically applied to structural practices, this factor reflects the maintenance of practices over the long term.
- **Design or Technique Factor:** Reflects the quality of the practice design

By default, the WTM will use the values from the "Existing Management Practices" worksheet for the "Future Management Practices" values. If expanded coverage of a particular practice is proposed, the user should enter values for the future condition. For example, if the watershed currently has 5 miles of riparian buffer, and a management plan proposes is to expand this by one mile, the data on the "Future Management Practices" tab should be edited by the user to include 6 miles of buffer.

TABLE 2. DATA REQUIREMENTS FOR EXISTING/FUTURE MANAGEMENT PRACTICES			
Practice	**Required Data (Green Cells)**	**Model Default Data (Blue Cells)**	**Notes**
Practices on the Existing Management Practices Sheet Only			
Turf Condition and Management Practices - Residential	• % of lawns bare/compacted • % of homes <10 years old • % off lawn area "highly managed" (high input)	• Residential turf area (calculated from Primary Sources) • Typical fertilizer applications/year • Fertilizer rate (lbs N/acre) • Distribution of fertilizer type (by %) • N and P analysis of fertilizers	Data for bare and compacted lawns and "highly managed" lawns can be gathered from field surveys. Fertilizer use and application rates are default values but can be replaced with survey or fertilizer sales data. Fertilizer losses are incorporated as a primary source (in loading rates) and as a secondary groundwater source. The turf runoff coefficient (on the primary sources tab) is modified based on the % if bare/compacted lawns.
Turf Condition and Management Practices – Other	• Management compared to residential turf (pull-down menu). Choices are "Same", "Comparatively High Management/Input", or "Better management/ nutrient management"	• Turf area calculated from Primary Sources	The simplified approach for this source "scales" loading compared with residential lawns rather than asking users for a separate assessment.
Structural Stormwater Practices	• Drainage areas to each practice • Impervious Area draining to each practice • Capture Discount (annual rainfall captured) • Design Discount • Maintenance Discount	• Turf area draining to each practice • Efficiencies and runoff reduction (%)	Although structural stormwater practices can be modified or added in the future condition, these practices are considered "Stormwater Retrofits" and accounted for separately. The model includes pop-up guidance for each discount factor.

TABLE 2. DATA REQUIREMENTS FOR EXISTING/FUTURE MANAGEMENT PRACTICES			
Practice	**Required Data (Green Cells)**	**Model Default Data (Blue Cells)**	**Notes**
Practices on Both Sheets			
Pet Waste Education*	• Program in Place (yes/no pull-down) • Number of dwelling units (unless already entered on the "Secondary Sources" worksheet) • Awareness of the Message	• Characteristics of the population (dog owners, fraction who clean up) • Fraction of the population willing to change their behavior. • Dog waste characteristics (waste production and pollutant concentrations) • Delivery factors (fraction of pollutants that reach the receiving water)	Concentrations in the "Primary Sources" tab include loads from pets. Consequently, the benefits of these programs will be subtracted from the "base loads" calculated in the primary and secondary sources tabs.
Erosion and Sediment Control	• Fraction of building permits regulated • Installation/ Maintenance discount	• Program efficiency	The model defaults and the recommended discounts can be refined based on field experience of ESC inspectors.
Street Sweeping	• Area Swept for residential streets, other streets, and parking lots. • Type of sweeper used • Sweeping frequency • Technique discount	• Sweeper efficiencies for TSS and nutrients	
Riparian Buffers	• Buffer length (miles) • Buffer width (feet) • Maintenance factor	• Buffer efficiencies • Treatability (fraction of the watershed captured). Calculated from other values.	Collect original buffer data from aerial photographs and field surveys. For the future condition, consider proposals to reforest the buffer, or to expand buffer protection.
Catch basin cleanouts	• Area captured (imperious cover) • Cleaning frequency • Disposal discount	• Efficiencies	
Marina Pumpouts	• Number of pumpouts	• Total number of berths (same as the value from "marinas" on the secondary source sheet) • Boats served per station • Fraction of owners willing to use	

Note: Cells in red font will show an "Enter Value" message if data entry is needed. If no data are entered, an error will result

TABLE 2. DATA REQUIREMENTS FOR EXISTING/FUTURE MANAGEMENT PRACTICES			
Practice	**Required Data (Green Cells)**	**Model Default Data (Blue Cells)**	**Notes**
Practices on the Future Management Practices Sheet Only			
Residential Lawn Care Education	• Awareness of the Message • Yes/No pull-down menus to ask if several specific lawn care education programs are in place	• Turf area • Additional forest area (from turf conversion) • Revised fertilizer application rate • Distribution of fertilizer type (by %) • N and P analysis of fertilizers • Ease of implementation for each education program type	The WTM uses the same calculations to calculate Nitrogen and Phosphorus loss, but uses the forecasted results of a future education program to revise fertilizer application rates. One program goal (Add soil amendments to lawn) is actually recorded on the "Retrofit Worksheet" described on the following pages.
Residential Impervious Cover Disconnection	• Program in place (yes/no from pull down menu) • Fraction of land where applicable • Fraction of population reached by the message	• Roof area (square feet) • Fraction willing to participate	The area of disconnection produced from this program is recorded as a stormwater retrofit, and appears in the stormwater retrofit worksheet.
Urban Downsizing	• Acres of urban land (in each land category) converted to another use • Acres of other land use created	• Loading and runoff rates for each land use	This practice applies only to a planned urban downsizing. If another land use is created or converted, the user will need to override the land use categories and loading rates.
Redevelopment with Improvements	• Land to be redeveloped (acres) • Impervious cover reduction (%) • Turf reduction (%)	N/A	
Stormwater Retrofits	N/A	N/A	Retrofit benefits are summarized on the Future Management Practices Worksheet, but data entry are in the Retrofit Worksheet

Note: Cells in red font will show an "Enter Value" message if data entry is needed. If no data are entered, an error will result.

TABLE 2. DATA REQUIREMENTS FOR EXISTING/FUTURE MANAGEMENT PRACTICES

Practice	Required Data (Green Cells)	Model Default Data (Blue Cells)	Notes
Stream Restoration	• Assessment option (from pull-down menu) **No Channel Protection** **Option 1: Estimate based on miles of stream stabilized** • Portion of stream channel unstable • Miles of stream channel stabilized • Fraction of watershed with flow control for the 1-year storm event. **Option 2: Enter Data From Stream Restoration Worksheet** • N/A	• For option 1, miles of unstable channel is calculated • For Option 2, data is imported from the Stream Restoration Worksheet described below	Channel protection refers to in-stream channel protection measures. The model allows separate options to allow the user to input local values from a detailed stream study that may have resulted in estimated removals that may differ from the model default. The model default values are considered conservative,
Illicit connection removal	• Fraction of system surveyed • Fraction of repairs made	N/A	These wastewater source reduction measures all calculated reductions by multiplying the user defined fraction or reduction in events by the fraction completed over the planning horizon timeline times the load from the original secondary source load.
CSO Repair/Abatement	• CSO Events after Repairs • Fraction complete		
SSO Repair/Abatement	• Goal (% reduction) • Fraction complete		

Note: Cells in red font will show an "Enter Value" message if data entry is needed. If no data are entered, an error will result.

TABLE 2. DATA REQUIREMENTS FOR EXISTING/FUTURE MANAGEMENT PRACTICES

Practice	Required Data (Green Cells)	Model Default Data (Blue Cells)	Notes
Septic System Education	• Program (yes/no pull down menu) • Awareness of the message • Fraction willing to change behavior		Septic system education and repair measures are combined to change the characteristics of the "Septic Systems" load. The WWTP load resulting from retiring septic systems is subtracted from the "point source reduction" benefit. If the retired septic systems are directed to a treatment plant in another watershed, override the WWTP loads and change them to 0.
Septic System Repair	• Program (yes/no pull down menu) • Fraction inspected • Percent willing to repair		
Septic System Upgrade	• Program (yes/no pull down menu) • Fraction inspected • Fraction willing to upgrade • Type of upgrade system • System efficiencies (if "other" selected as system type)	• System efficiencies (except for "other")	
Septic System Retirement (convert to WWTP)	• Fraction of systems inspected • % failing among retired systems • % w/in 100' of a waterway among retired systems • WWTP Efficiencies	• WWTP loads	
Point Source Reduction	• Reduction (lbs/year of billion/year)	• WWTP load (negative) from septic system retirement	

Note: Cells in red font will show an "Enter Value" message if data entry is needed. If no data are entered, an error will result.

Retrofit Worksheet

The retrofit worksheet is a worksheet to enter individual stormwater retrofit practices. Stormwater retrofits are a type of future management practice. The results from this worksheet are imported to the "Future Management Practices" worksheet and summarized on that page. The Retrofit Worksheet allows the user to enter detailed design information for each practice. The worksheet asks for general practice information (and data entry options) at the top of the sheet, and then asks for individual practice information in the main section of the worksheet in the "Basic Site Information" table. (Figure 6).

Design Storm (Inches)	

Water Quality Volumes	Provide Full WQv	100%

Discount Factors			
Design	Varies (Enter in Column P)	Value:	N/A
Maintenance	Varies (Enter in Column R)	Value:	N/A

	Basic Site Information. Make sure to Enter Data in Green Cells					
	Area Captured (acres)	Impervious Percentage	Is this a Retrofit of an Existing Facility?	What Practice Was the Original Facility?	Dominant Soil Type in Drainage Area	Depth to Groundwater (from Practice Bottom)
Practices from Education Programs						
Rooftop Disconnection	0.0	100%	No	N/A	A Soils	>5 Feet
Soil Amendments	0.000	0%	No	N/A	C Soils	>5 Feet
Practice Type						
Enter Practice			No	N/A	C Soils	>5 Feet
Enter Practice			No	N/A	C Soils	>5 Feet
Enter Practice			No	N/A	C Soils	>5 Feet
Enter Practice			No	N/A	C Soils	>5 Feet
Enter Practice			No	N/A	C Soils	>5 Feet
Enter Practice			No	N/A	C Soils	>5 Feet
Enter Practice			No	N/A	C Soils	>5 Feet
Enter Practice			No	N/A	C Soils	>5 Feet
Enter Practice			No	N/A	C Soils	>5 Feet
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Enter Practice			No	N/A	C Soils	>5 Feet
Enter Practice			No	N/A	C Soils	>5 Feet
Enter Practice			No	N/A	C Soils	>5 Feet
Enter Practice			No	N/A	C Soils	>5 Feet
Enter Practice			No	N/A	C Soils	>5 Feet
Enter Practice			No	N/A	C Soils	>5 Feet
Enter Practice			No	N/A	C Soils	>5 Feet
Enter Practice			No	N/A	C Soils	>5 Feet

Figure 6. The Retrofit Worksheet, showing the generalized information at the top and individual practice data at the bottom (main section).

Design Storm:

The top of the retrofit worksheet asks the user for the design storm (in inches). This value should reflect the water quality design storm (typically about 1"). This is a critical value that needs to be entered.

Water Quality Volume (WQv)
The target WQv for each practice is the runoff volume from the design storm. Ideally, practices would be sized to capture this volume, but in some cases (particularly for retrofits) the practice cannot be sized to capture the entire volume. In the upper portion of the retrofit worksheet, the user selects from a pull-down menu to determine how to enter the water quality volume, among three choices:

Option 1. Provide the full water quality volume at all practices
If the user chooses this option, no further data entry is required.

Option 2. Provide a consistent fraction of the water quality volume (e.g., 80% of the Target WQv for all practices)
For this option, the user needs to enter the % of the WQv provided in all sites. The value will be entered in cell E5. When this data entry option is selected, an "Enter Value" value appears in this cell.

Option 3. Provide a different water quality volume at each site.
If this option is selected, the user needs to enter the WQv for each practice (in Column J) under the "WQv Provided" heading.

The third option provides the most flexibility, so it is the best choice when a detailed retrofit inventory has been conducted and design information is available. The other options presented represented a way to evaluate "what if" scenarios across a wide range of practices.

Discount Factors
For the design and maintenance factors, the user may either select a single value for all practices (entered in Column F), or to enter a different value for each practice. Note that, if the "Varies" option is selected, the discount factors need to be entered for each practice, in columns P and R. (Scroll over to enter these data).

Basic Site Information
For each practice, select the practice type from the pull-down menu. For each practice, the basic required data includes the following:

- Area captured (acres)
- Impervious Percentage
- Soil in the drainage area
- Depth to groundwater (from practice bottom)

This section also asks the user if this is a "new" retrofit or a retrofit of an existing facility. If the practice is a retrofit of an existing facility, such as a conversion of a dry pond to a wet pond, the user selects the type of *original* practice from a pull-down list.

Effectiveness and WQv of Retrofits
This section of the retrofit worksheet provides the target water quality volume. If the WQv needs to be input, an "Enter Value" will appear in the cells in Column J. Effectiveness (%) will be derived from a look-up table, depending on the practice type, but the user will need to input values if "Other" is selected as a practice option.

Effects of the Original Practice
The WTM reports the pollutant removal of the original practice (if this practice is a retrofit of an existing practice). In general, these cells should not be modified, but may be overridden if the user has detailed data about the effectiveness of a particular existing practice.

Practices from Education Programs
Data for rooftop disconnection and soil amendments are imported into the retrofit worksheet from the "Future Management Practices" sheet. The user does not need to enter data in these sections, although the soil type or other practice features can be modified as needed.

Stream Restoration Worksheet
The stream restoration worksheet allows the user to enter the benefits of individual stream restoration practices, by inputting the length of stream restored, and pollutant and nutrient reductions in pounds per foot restored. The data from this worksheet is then transferred to the Future Management Practices tab of the WTM.

Future Land Use
This tab is simply a forecast of future land use or land cover in the watershed. The only caveat for this portion of the WTM is that the land use categories **must be the same** as those reported in the Primary Sources tab, or errors will occur. Another potential error on this sheet results when total land area either exceeds or is less than the original watershed area. The value under "Total Acres" will report an error if the areas are not the same.

New Development
This sheet includes four sections of data input: New Development, Controls on New Development, Data to Quantify Wastewater Loads, and Active Construction. Data requirements for each section are as follows:

New Development
This section sums the uncontrolled pollutant loads from new development. No data entry is needed, but the user can modify the characteristics of each land use category by adjusting pollutant concentrations, impervious cover and turf cover for each land use type.

Stormwater Controls on New Development
This section describes and quantifies the benefits of stormwater controls to be implemented on new development. The WTM allows three different program options. Each of these options reflects stormwater regulations that are used throughout the United States.

> <u>Option 1: Meet a specific pollutant removal target</u>
> If this option is selected, the user needs to enter the removal efficiencies in cells marked "Enter Value" next to the "Target % Removal" row.
>
> <u>Option 2: Meet a target load</u>
> If this option is selected, the user needs to enter the target load in lbs/acre/year, billion/acre/year inches/year (for runoff volume).

<u>Option 3: Show no net increase in load on each parcel</u>
If this option is selected, no further data are needed.

<u>Discount Factors</u>
Four discount factors (% regulated, capture discount, design discount, and maintenance discount) are applied to the target removals. By default, the data in these cells is derived from data in the "Existing Management Practices" and "Future Management Practices" sheets. While no data are required in this section, the user may override these default values to reflect different levels of program implementation in the future.

<u>Channel Protection</u>
Enter "yes" to answer the question, "Is channel protection required?" if there is some requirement in place to control small (1-year) storms either through detention or runoff reduction, in order to protect stream channels.

Data to Quantify Wastewater Loads
This section requires data to quantify the loads from future wastewater sources, including Septic Systems, SSOs, CSOs, Illicit Connections, and WWTP Dischargers. This section uses simplified calculations to forecast loads from these sources. Data required are summarized in Table 3.

TABLE 3. DATA REQUIRED TO CALCULATE FUTURE WASTEWATER LOADS

Source	Data Required
Septic Systems	• New septic system customers • Septic system failure rate • Septic system efficiency (High/medium low) compared to the current systems.
SSOs	• Miles of sewer constructed • SSOs/mile
Illicit Connections	• Percent of population illicitly connected
WWTP Discharges	• New wastewater customers (households) • WWTP Efficiency

Active Construction
The WTM calculates loads from active construction based on three user inputs: the program efficiency, % of new development regulated, and the "Maintenance Discount." By default the WTM imports data from the "Future Management Practices" worksheet, but these data may be adjusted by the user.

SECTION 4. INTERPRETING OUTPUT DATA

Final model results are reported in three summary sheets: Loads with Existing Practices, Loads with Future Practices, and Loads with New Growth. Each of these sheets uses exactly the same format (See Figure 6). The summary output sheets divide the load into two categories: Loads to Surface Waters, and Loads to Groundwater. The loads to Surface Waters are then further subdivided into Storm Loads (e.g., urban runoff) and Non-Storm Loads (e.g., Illicit Discharges).

Existing Loads to Surface Waters					
	TN lb/year	TP lb/year	TSS lb/year	Fecal Coliform billion/year	Runoff Volume (acre-feet/year)
Urban Land	-	-	-	-	-
Active Construction	-	-	-	-	-
SSOs	-	-	-	-	-
CSOs	-	-	-	-	-
Channel Erosion	-	-	-	-	-
Road Sanding	-	-	-	-	-
Forest	-	-	-	-	-
Rural Land	-	-	-	-	-
Livestock	-	-	-	-	-
Illicit Connections	-	-	-	-	-
Marinas	-	-	-	-	-
Point Sources	-	-	-	-	-
Septic Systems	-	-	-	-	-
Open Water	-	-	-	-	-
Total Storm Load	-	-	-	-	-
Total Non-Storm Load	-	-	-	-	-
Total Load to Surface Waters	-	-	-	-	-

Existing Loads to Groundwater (Contributed from Urbanization). Note. Model does not deliver to receiving surface waters.			
	TN lb/year	TP lb/year	Fecal Coliform billion/year
Urban Land	0	-	-
Septic Systems	-	-	-
Total	0	-	-

Figure 7. Output from the "Loads with Existing Practices" Worksheet

Surface Loads

While the WTM is not a continuous model, some users find it useful to separate "storm loads" from "non-storm loads." This is particularly true for bacteria loads, where violations typically occur during storm events.

Loads to Groundwater

Although the WTM is not a groundwater model, it does estimate the loads (from urban land and septic systems) delivered to the groundwater. It is important to note that the WTM *does not* estimate the amount of this load that is ultimately delivered to the surface water. However, it *does* account for soil infiltration, so it reflects expected delivery to the groundwater system, rather than the entire mass of pollutants infiltrated.

Summaries on Other Sheets

Many of the calculation sheets also offer some summary data that may be useful for comparing practice options. These data are summarized in Table 4.

TABLE 4. DATA REQUIRED TO CALCULATE FUTURE WASTEWATER LOADS

Sheet	Summary Data	Notes
Primary Sources	Annual Surface Loads (pre-BMP) for each land use and summed in Columns P through U Total loads are divided into *storm* and *non-storm* components	The summary data on this sheet are coded grey because they are not highly useful. Although these summaries compare the contributions from each land use, the data can be deceptive because they do not include BMP implementation.
Secondary Sources	The purple cells at the bottom of the sheet report pollutant loads from each secondary source. These loads are then summed and divided into storm load, non-storm load, and loads to groundwater.	These data can be useful, but also do not include BMP implementation.
Existing Management Practices	The summary sheet at the bottom of the page (purple cells) tabulates the load reduction (or runoff reduction), from each practice The summary the divides the total load into storm, non-storm and groundwater components.	Some load reductions may be negative. This *negative reduction* actually represents an *increased load* resulting from a management practice. One example of this is the load from infiltration practices to the groundwater. The purple cells in the Future Management Practices sheet are the most useful, since they reflect the benefit of the proposed practices.
Future Management Practices	These load reductions are summarized in two sections. Grey cells reflect the load reductions from *all practices* (both existing and future). Purple cells reflect the *net reduction* from future management practices.	
Retrofit Worksheet	The benefits, and loads to groundwater, of each practice are summed in the purple cells to the right. In addition, the model sums the total benefits from each practice.	All of these data are transferred to the Future Management Practices sheet, and aggregated by practice type.
New Development	The net additional load from each source is summed at the bottom of this sheet in purple cells.	

REFERENCES

Haith, D., R. Mandel and R. Wu. 1992. *Generalized Watershed Loading Functions, User's Manual*. Department of Agricultural and Biological Engineering. Cornell University. Ithaca, NY

APPENDIX B

APPENDIX C

CNY RPDB - Modelling of POCs in the USA

Inventory of Input Variables and Settings for the Watershed Treatment Model (WTM)

Notes:
- The Table below follows the format of the WTM.
- The red highlight indicates items where model inputs or assumptions, or organization was modified. The "comments" contains information to this effect.
- The WTM Model has additional Tabs for "Future Land Use" and "New Development" to modify the characteristics of the Land Use Category, if desired.

Subject Criteria	Information Needed	Information Available	Comments / Source of Information
PRIMARY SOURCES			
Land Use			
Watershed Area	Acreage of Various land-use types	GIS / CADD Orthoimagery	GIS-based analysis of aerial photos
Watershed Data			
Annual Rainfall	Annual Rainfall Amounts	NRCS/NRCC Data, as hosted on Cornell University's website	Use average depth for all municipalities, same for 2008 and 2011
Stream Length	Total Stream Length	GIS / CADD Orthoimagery	This information measured from USGS blue lines, mostly from GIS file of 303-d list
Soils Information			
Hydrologic Soil Group	Percentage of each Hydrologic Group for the soils in the watershed	NRCS/USDA websoil mapping	GIS analysis of data obtained from the NRCS website
Depth to Groundwater	Depth to Groundwater	NRCS/USDA websoil mapping	GIS analysis of data obtained from the NRCS website
SECONDARY SOURCES			
General Sewage Use Data			
Dwelling Units	Number of Single-Family, detached dwelling units	GIS/CADD County tax data base	GIS analysis of county tax records
Nutrient Concentration in Stream Channels			
Soil P (%), & TN (%)	Concentrations	Figure 5 of the WTM 2010 User's Guide	Assumed, same for all municipalities, same for 2008 and 2011

APPENDIX C

CNY RPDB - Modelling of POCs in the USA

Inventory of Input Variables and Settings for the Watershed Treatment Model (WTM)

Subject Criteria	Information Needed	Information Available	Comments / Source of Information
On-Site Sewage Disposal Systems			
Unsewered dwelling units (% of total)	# of unsewered dwelling units, total number of dwelling units	County GIS tax records	GIS analysis - not available from online records, requested from County. A cell was added to allow for entering the number of unsewered dwelling units. The percentage is then calculated in the destination cell.
% of Septic Systems <100' to waterway	# of septic systems close to water, # of septic systems	none	Assumed 2%, same for all municipalities, same for 2008 and 2011.
Soils	soil types - choices of "sandy" or "clay/mixed soils"	NRCS/USDA websoil mapping	Assumed "clay/mixed soils", same for all municipalities, same for 2008 and 2011
System type	type of on-site system	some, but not electronic and not comprehensive	Assumed 100% conventional systems
Current septic system management	charateristics of system management	none	Assumed "medium"
Typical separation from groundwater	Typical separation from groundwater	NRCS/USDA websoil mapping	Assumed "3-5 feet", same for all municipalities, same for 2008 and 2011
Density (#/acre)	average number of septic systems per acre	none	Assumed "<1/acre", same for all municipalities, same for 2008 and 2011
SSO's			
Miles of Sanitary Sewer	Miles of Sanitary Sewer	Data provided by Onondaga County WEP	GIS analysis
CSO's			
Median Storm Event (inches)	Median Storm Event (inches)	table of precipitation data from County CSO report	NOT USED
Sewershed Area	Sewershed Area (acres)	County CSO report	NOT USED
Sewershed Impervious Cover	Sewershed Impervious Cover (%)	County CSO report	NOT USED
Illicit Connections			
Fraction of watershed population illicitly connected	Fraction of watershed population illicitly connected	some records of discovered illicit discharges	assumed 0.1%, same for all municipalities, same for 2008 and 2011
Number of businesses	Number of businesses with illicit connections	some records of discovered illicit	assumed 2, same for all municipalities, same for 2008 and 2011
Urban Channel Erosion			
Method	Select method of assessment	none	assumed "method 1", same for all municipalities, same for 2008 and 2011
Assessment of Channel Erosion	Low, moderate, high	none	assumed "low", same for all municipalities, same for 2008 and 2011
Livestock			

APPENDIX C

CNY RPDB - Modelling of POCs in the USA

Inventory of Input Variables and Settings for the Watershed Treatment Model (WTM)

Subject Criteria	Information Needed	Information Available	Comments / Source of Information
Livestock	Number of animals in each category (Cattle, Chickens, Turkeys, Pigs, etc)	2007 and 2011 populations for the 6 regulated CAFO's that are within the study area.	NOT USED
Marinas	Number of berths, length of season (days)	not used	not used
Road Sanding	Sand application (lbs/year)	Tons of sand applied in a year	CNY RPDB survey of municipalities
	Miles of open and closed drainage roads	statistics from municipalities	CNY RPDB survey of municipalities
Non-Stormwater Point Sources			
Point Sources	For each Point Source, provide Flow (MGD), and pollutant/bacteria concentrations	County records, SPDES permits	NOT USED
EXISTING MANAGEMENT PRACTICES			
Turf Condition & Management Practices			
Residential Turf Mngm't	% of lawns bare/compacted	None	assumed 10%, same for all municipalities, same for 2008 and 2011
	% of homes less than 2 years old	tax parcel data	GIS analysis of County tax records. The original version of the WTM model considered the % of homes <10 years old. Given the likelihood of fertilization to establish lawns for that length of time AND the implementation of the County's fertilization law, this variable was changed to consider the % of homes < 2 years old.
	% of lawn "highly managed" (high input)	None	assumed 10%, same for all municipalities, same for 2008 and 2011
Turf Mngm't - Other	Select type of Management from menu (Same, High Input, or Better Management)	None	assumed "same", same for all municipalities, same for 2008 and 2011
Pet Waste Education	Program in place? (Y or N)	CNY RPDB survey of municipalities	
	Awareness of Message (Fraction of Population)	None	For all municipalities 5% was used for 2008. 8% was used for 2011 to reflect the CNY RPDB's efforts that started after 2008.
Erosion & Sediment Control	Fraction of Building Permits Regulated;	None	assumed 80%, same for all municipalities, same for 2008 and 2011
	Installation / Maintenance discount	None	assumed 0.75, same for all municipalities, same for 2008 and 2011
	Number of acres swept	CNY RPDB survey of municipalities	used data from CNY RPDB survey of municipalities - sweeping data entered in municipality SUMMARY sheet

Subject Criteria	Information Needed	Information Available	Comments / Source of Information
Street Sweeping	Type of sweeper used	CNY RPDB survey of municipalities	used data from CNY RPDB survey of municipalities
	Sweeping frequency	CNY RPDB survey of municipalities	used data from CNY RPDB survey of municipalities
	Technique Discount (parking restrictions and operator training)	CNY RPDB survey of municipalities	used data from CNY RPDB survey of municipalities
Structural Stormwater Practices			
Structural Stormwater Practices	List of the Various BMP Type Practices,the Drainage Area to each practice, impervious area to each practice, the Capture Discount (annual rainfall captured), Design Discount, and Maintenance Discount.	Aerial photos	Data taken from aerial photo analysis
Riparian Buffers	Buffer Length (miles), and Width (feet)	None	not used
Catch Basin Cleanouts			
Catch Basin Cleanouts	IMPERVIOUS Drainage area captured by catch basins that are cleaned monthly	CNY RPDB survey of municipalities	Most catch basin data did not show cleanings of these frequencies - values were extrapolated and are shown in "semi-annually" cell. Impervious area captured was taken as 50% of total impervious in study area for URBAN areas and 15% for NON-URBAN areas. Cells were added to the WTM to allow for entry of # catch basins and # catch basins cleaned.
Catch Basin Cleanouts	IMPERVIOUS Drainage area captured by catch basins that are cleaned semi-annually	CNY RPDB survey of municipalities	
Catch Basin Cleanouts	Disposal Discount - policy for disposal of materials removed	none	assumed 1.0 (no discount), same for all municipalities, same for 2008 and 2011
Marina Pumpouts	Number of Pumpouts	None	not used

APPENDIX D

SAMPLE TOWN	SAMPLE River	NON-URBAN	2008

Green cells need to be completed by the user. Green tabs require user input
Blue cells have default or calculated values but may be substituted
Grey cells should generally not be changed
Purple Cells Reflect "Bottom Line" Loads or Load Reductions. Purple Tabs Summarize Loads from Other Sheets

PRIMARY SOURCES - Land Use

Watershed				Concentrations					Annual Loading Rates			Annual Load						Annual Runoff Volume	
		Area (Acres)	Impervious Cover (%)	Turf Cover (%)	TN (mg/l)	TP (mg/l)	TSS (mg/l)	FC (MPN/100 ml)	TN (lb/acre)	TP (lb/acre)	TSS (lbs/acre)	FC (# billion/acre)	Runoff (in/year)	TN (lb/year)	TP (lb/year)	TSS (lbs/year)	FC (# billion/year)	(ac-inches)	(acre-feet)
Category	Detailed Description																		
Residential	LDR (<1du/acre)	0	12%	70%	2	0.26	55	1800	5.8	1.5	121	18	10	-	-	-	-	-	0
	MDR (1-4 du/acre)	0	21%	63%	2	0.26	55	1800	6.6	1.5	148	22	12	-	-	-	-	0	0
	HDR (>4 du/acre)	0	33%	54%	2	0.26	55	1800	7.7	1.6	184	27	15	-	-	-	-	0	0
	Multifamily	0	44%	45%	2	0.26	55	1800	8.7	1.6	216	32	17	-	-	-	-	0	0
				0%	2	0.26	55	1800	0.5	0.1	14	2	1	-	-	-	-	0	0
Developed Land	Lawns	5000	0%	100%	2	0.26	55	1800	5.7	1.8	104	15	8	28,346	8,856	517,742	77,224	41652.63	3471.0525
	Impervious	2000	100%	0%	2	0.26	55	1800	13.9	1.8	383	57	31	27,825	3,617	765,191	114,132	61560	5130
				0%	2	0.26	55	1800	0.5	0.1	14	2	1	-	-	-	-	0	0
				0%	2	0.26	55	1800	0.5	0.1	14	2	1	-	-	-	-	0	0
				0%	2	0.26	55	1800	0.5	0.1	14	2	1	-	-	-	-	0	0
Commercial	Commercial	0	72%	22%	2	0.26	55	1800	11.3	1.7	299	45	24	-	-	-	-	0	0
		0	72%	22%	2.0	0.26	55	1800	11.3	1.7	299	45	24	-	-	-	-	0	0
				0%	2.0	0.26	55	1800	0.5	0.1	14	2	1	-	-	-	-	0	0
				0%	2.0	0.26	55	1800	0.5	0.1	14	2	1	-	-	-	-	0	0
				0%	2.0	0.26	55	1800	0.5	0.1	14	2	1	-	-	-	-	0	0
Roadway	Roadway	8.3	80%	16%	2	0.26	55	1800	12.1	1.7	323	48	26	100	14	2,683	400	215.8197022	17.9849752
			80%	16%	2.0	0.26	55	1800	12.1	1.7	323	48	26	-	-	-	-	0	0
				0%	2.0	0.26	55	1800	0.5	0.1	14	2	1	-	-	-	-	0	0
				0%	2.0	0.26	55	1800	0.5	0.1	14	2	1	-	-	-	-	0	0
				0%	2.0	0.26	55	1800	0.5	0.1	14	2	1	-	-	-	-	0	0
Industrial	Industrial	0	53%	38%	2	0.26	55	1800	9.6	1.6	243	36	20	-	-	-	-	0	0
				0%	2	0.26	55	1800	0.5	0.1	14	2	1	-	-	-	-	0	0
				0%	2	0.26	55	1800	0.5	0.1	14	2	1	-	-	-	-	0	0
				0%	2	0.26	55	1800	0.5	0.1	14	2	1	-	-	-	-	0	0
				0%	2	0.26	55	1800	0.5	0.1	14	2	1	-	-	-	-	0	0
Forest	Forest	17.8							2.5	0.2	100	12	1	45	4	1,780	214	13.149216	1.095768
									2.5	0.2	100	12	-	-	-	-	-	0	0
									2.5	0.2	100	12	-	-	-	-	-	0	0
									2.5	0.2	100	12	-	-	-	-	-	0	0
									2.5	0.2	100	12	-	-	-	-	-	0	0
Rural	Rural	2000							4.6	0.7	100	39	1	9,200	1,400	200,000	78,000	1477.44	123.12
									4.6	0.7	100	39	-	-	-	-	-	0	0
									4.6	0.7	100	39	-	-	-	-	-	0	0
									4.6	0.7	100	39	-	-	-	-	-	0	0
									4.6	0.7	100	39	-	-	-	-	-	0	0
									4.6	0.7	100	39	-	-	-	-	-	0	0
									4.6	0.7	100	39	-	-	-	-	-	0	0
									4.6	0.7	100	39	-	-	-	-	-	0	0
									4.6	0.7	100	39	-	-	-	-	-	0	0
									4.6	0.7	100	39	-	-	-	-	-	0	0
Open Water	Open Water								12.8	0.5	155			-	-	-	-	0	0
Active Construction	Active Construction				1	0.2	680	0	0	0	0	-		-	-	-	-	0	0
Total	Total Acres	9026	2007	5001					7.258503454	1.5390524	164.788295	29.90992187		65,516	13,892	1,487,396	269,970	104,919	8,743
Stormwater Load														60,894	13,471	1,467,218	269,970	104,919	8,743
Non-Stormwater Load														4,622	421	20,178	-		

Partitioning Coefficients for Rural and Forest Land

Pollutant	TN	TP	TSS	FC
Fraction as Storm Load	50%	70%	90%	100%

Watershed Data

Annual Rainfall (inches)	36
Watershed Area (acres)	9026
Stream Length (miles)	0.00

Soils Information

		Runoff Coefficients				Land-Use Specific Runoff Coefficients					
	Soil Fraction(%)	Impervious	Turf	Forest	Rural	Active Construction	rural				
HYDROLOGIC SOIL GROUP											
A Soils	23%	0.95	0.15	0.02	0.02	0.5					
B Soils	35%	0.95	0.20	0.03	0.03	0.5					
C Soils	10%	0.95	0.22	0.04	0.04	0.5					
D Soils	32%	0.95	0.25	0.05	0.05	0.5					
		0.95	0.26	0.0351	0.0351	0.5					
DEPTH TO GROUNDWATER											
<3 Feet	50%										
3-5 Feet	25%										
>5 Feet	25%										

SECONDARY SOURCES	SAMPLE TOWN	SAMPLE River	NON-URBAN	2008

General Sewage Use Data

Dwelling Units	191	Indi duals/Dwelling Unit	2.7
		Water Use (gpcd)	70
Unsewered Dwelling Units	100	Wastewater Characteristics	
		TN (mg/l)	60
		TP (mg/l)	10
		TSS (mg/l)	400
		FC (MPN/100 ml)	10,000,000

Nutrient Concentration in Stream Channels

	Concentration	Enrichment Factor
Soil P(%)	0.150%	2
Soil TN (%)	0.150%	2

On-Site Sewage Disposal Systems

Unsewered Dwelling Units(% of total)	52.36%	Failure Rates	10%		
% of Septic Systems <100' to waterway	2%				
			Normal	Adjacent to Waterway	
Soils	Clay/Mixed Soils	Bacteria decay	0.20%	13%	
		Delivery ratio	50%	100%	
		TN	TP	TSS	Bacteria (Billions)
Untreated Sewage Delivered to Septic Systems		3447	575	22982	2608200
System Type	% of Systems	TN Efficiency	TP Efficiency	TSS Efficiency	Bacteria Log Reduction
Conventional	100%	28%	57%	72%	3.5
Intermittent Sand Filter		55%	80%	92%	3.2
Recirculating Sand Filter		64%	80%	90%	2.9
Water Separation System		83%	30%	60%	3.0
Other		0%	0%	0%	0.0
Combined Efficiency		28%	57%	72%	3.5
Adjusted Efficiency (density)		28%	57%	72%	3.5
Current Septic System Management	Medium. Inspection at installation, education to encourage ongoing maintenance				
Typical Separation from Groundwater	3-5 Feet				
Density (#/acre)	<1/acre				
		TN	TP	TSS	Bacteria
Removal by soil below the leach field		10%	80%	100%	100%

SSOs

Miles of Sanitary Sewer	0.65	Overflows/1,000 Miles of Sewer	140
Fraction of Load as Storm Flow	50%	Volume per Overflow (gallons)	90,000

CSOs

Median Storm Event (inches)		# of CSOs/year	0
Sewershed Area (acres)		Capacity of CS system (rainfall depth in inches)	0.1
Sewershed Impervious Cover (%)		Characteristics of CSOs	
		TN (mg/l)	10
		TP (mg/l)	2
		TSS (mg/l)	200
		FC (MPN/100 ml)	6,400,000

Illicit Connections

Fraction of WS Population Illicitly Connected	0.1%			
# of Illicit Connections	0.19			
Number of Businesses	2			
Fraction of Businesses with Illicit Connections	0.1			
Fraction of Business Connections that are Wash Water Only	0.9			
Wash Water Flow (gpd)	100			
Total Flow/business (gpd)	150			
	TN	TP	TSS	FC
Wash Water Concentrations	15	10	150	0
Total Flow Concentrations	30	10	225	3,300,000

Urban Channel Erosion (Applies only to Stream Reaches in Urban Portions of the Watershed)

Method (Select from List)	Method 1. Estimate based on typical estimates of channel erosion rates.
Method 1. Estimate based on typical estimates of channel erosion rates.	
Assessment of Channel Erosion	Low: 25% of watershed sediment load. Channels largely armored, or stable.
Method 2. Back calculate based on known watershed sediment loading.	
Total Watershed Loading (including Channel Erosion) in tons/year	*N/A*
Method 3. Estimate based on other sediment study results.	
Sediment Load from Channel Erosion (tons/year)	*N/A*

Livestock

	Animals (#)	% Exposed to Runoff	N (lbs/animal/year)	N load	P (lbs/animal/year)	P Load	Bacteria (billions/animal/year)	Bacteria Load
Dairy Cattle	0	100%	175	0	30	0	2,000	0
Layers	0	15%	0.9	0	0.4	0	88	0
Broilers	0	15%	0.8	0	0.2	0	88	0
Turkeys	0	15%	3	0	0.8	0	47	0
Pigs	0	100%	32	0	7.4	0	3,200	0
Delivery Ratios	0		15%	0	10%	0	5%	0

Marinas

berths	0	typical occupancy (fraction of season)	0.5
season length (days)	0	flow rates (gpcd)	8
		individuals per boat	2

Road Sanding

Sand Application (lbs/year)	0	Delivery ratio for Closed Section Roads	0.9
Fraction of Roads that are Open Section	25%	Delivery ratio for Open Section Roads	0.35

Non-Stormwater Point Sources

	Flow (MGD)	N Concentration (mg/l)	N Load (lbs/year)	P Concentration (mg/l)	P Load (lbs/year)	TSS Concentration	TSS Load (lbs/year)	Bacteria Concentration	Bacteria Load (Billion/year)
Point Source 1			0		0		0		0
Point Source 2			0		0		0		0
Point Source 3			0		0		0		0
Point Source 4			0		0		0		0
Point Source 5			0		0		0		0
Point Source 6			0		0		0		0
Point Source 7			0		0		0		0
Point Source 8			0		0		0		0
Point Source 9			0		0		0		0
Point Source 10			0		0		0		0

Total Annual Loads

	Pollutant Loads			
	N Load (lbs/year)	P Load (lbs/year)	TSS Load (lbs/year)	Bacteria Load (billion/year)
Septic Systems - Surface	176	29	1,172	934
Septic Systems - Subsurface	2,011	44	0	0
Fertilizer - Subsurface	292,632	5,565		
SSOs	4	1	27	3,096
CSOs	0	0	0	0
Illicit Connections	8	2	54	5,117
Channel Erosion	1,467	1,467	489,073	0
Hobby Farms/Livestock	0	0	0	0
Marinas	0	0	0	0
Road Sanding	0	0	0	0
Point Source Discharges	0	0	0	0
Total Secondary Load	**296,298**	**7,108**	**490,326**	**9,147**
Total Secondary Load to Surface Waters				
Storm Load	1,469	1,468	489,086	1,548
Non-storm Load (not to groundwater)	186	31	1,240	7,599
Total Secondary Load to Groundwater				
Groundwater Load	294,643	5,609	0	0

SAMPLE TOWN	SAMPLE River	NON-URBAN	2008

Turf Condition and Management Practices - Residential

Residential Turf Area	5000.0		
% of Lawns Bare/ Compacted	10%		
Factors that Affect Nutrient Loading			
Typical # of Applications/Year	1.1		
% of Homes <2 Years Old	2.1%		
% of Lawn Area "Highly Managed" (high input)	10%		
Baseline (Recommended) Fertilizer Rate (N lb/acre)	150		
Estimated Average Fertilizer Application (N lb/acre)	156.025		
		Analysis	
Form	% of Fertilizer Use (N Application)	N	P
Organic	0%	0.8	0.3
Soluble/Urea	50%	35	3
Slow Release	50%	24	5
Phosphorus Free	0%	10	0
	N	P	
Total Fertilizer Application Rate (Lb/year)	780,125	114697	

Turf Condition and Management Practices - Other

Turf Category	Area (acres)	Management Compared to Residential Turf	
Commercial	0.0	Same	
Roadway	1.3	Same	
Industrial	0.0	Same	

Pet Waste Education

Program in Place?	yes		
Both			
# of dwelling units	191		
Fraction of Households with a Dog	40%	Waste Production (lbs/dog-day)	0.32
Owners who Walk their Dogs (fraction)	50%	N Concentration (lb/lb)	0.23
Owners who Clean Up (fraction)	60%	N Delivery Factor	0.25
Fraction willing to change behavior	60%	P Concentration (lb/lb)	0.01
Awareness of Message (Fraction of Population)	5%	P Delivery Factor	0.75
		Bacteria Concentration(billion/lb)	10
		Bacteria Delivery Factor	0.05

Erosion and Sediment Control

Program Efficiency	70%
Fraction of Building Permits Regulated	80%
Installation/ Maintenance Discount	0.75

Street Sweeping

Sweeper Type	Streets Swept (Acres) Residential	Streets Swept (Acres) Other Streets	Parking Lots Swept (acres)	Efficiencies - Residential Nutrients	Efficiencies - Residential TSS	Efficiencies - Other roads Nutrients	Efficiencies - Other roads TSS
Mechanical				24%	30%	4%	5%
Regenerative Air				51%	64%	18%	22%
Vacuum Assisted				62%	78%	63%	79%
Sweeping Frequency	monthly	monthly	monthly				
Technique Discount	0.5						

Structural Stormwater Management Practices

BMP Type	Total Drainage Area	Impervious Area (acres)	Turf Area (acres)	Efficiency (%)				Runoff		
				TN	TP	TSS	Bacteria	C/D Soils	A/B Soils	Weighted
Dry Water Quantity Pond	0.00	0.00	0.00	5%	10%	10%	0%	0%	0%	0%
Dry Extended Detention Pond	0.00	0.00	0.00	10%	15%	55%	0%	0%	15%	9%
Wet Pond	0.00	0.00	0.00	30%	50%	80%	70%	0%	0%	0%
Wetland	0.00	0.00	0.00	25%	50%	75%	80%	0%	0%	0%
Filters	0.00	0.00	0.00	30%	60%	80%	80%	0%	0%	0%
Green Roof	0.00	0.00	0.00	45%	45%	80%	0%	45%	45%	45%
Rooftop Disconnection	0.00	0.00	0.00	25%	25%	85%	0%	25%	50%	40%
Permeable Pavement	0.00	0.00	0.00	60%	60%	75%	0%	45%	75%	62%
Grass (open) Channel	0.00	0.00	0.00	30%	25%	60%	0%	10%	20%	16%
Dry Swale (bioswale, WQ swale)	0.00	0.00	0.00	55%	50%	85%	0%	40%	60%	52%
Wet Swale	0.00	0.00	0.00	25%	20%	70%	0%	0%	0%	0%
Raintanks and Cisterns	0.00	0.00	0.00	40%	40%	40%	0%	40%	40%	40%
Soil Amendments	0.00	0.00	0.00	50%	50%	75%	0%	67%	50%	57%
Sheetflow to Open Space (excluding riparian buffers)	0.00	0.00	0.00	50%	50%	85%	0%	50%	75%	65%
Grassed Filter Strips	0.00	0.00	0.00	50%	50%	85%	0%	50%	50%	50%
Bioretention	0.00	0.00	0.00	65%	55%	85%	90%	40%	50%	46%
Infiltration Practices	0.00	0.00	0.00	55%	65%	95%	85%	50%	90%	73%
			0.00							
Total	0.00	0.00	0.00	0%	0%	0%	0%	0%	0%	0%

Treatability	Capture Discount (D1)	Design Discount (D2)	Maintenance Discount (D3)
0%	90%	1	0.6

Riparian Buffers

	Buffer 1	Buffer 2	Buffer 3	Buffer 4
Buffer Length (Miles)				
Buffer Width (ft)				

	Efficiency			
TN	TP	TSS	Bacteria	Runoff Reduction
50%	50%	85%	0%	65%
Treatability	0%			
Maintenance	0.0			

Catch Basin Cleanouts

NOTE: Data is entered in the cells to the right.

	Impervious Area Captured (Acres)	Efficiency Nutrients	TSS
Monthly Cleaning	0	15%	25%
Semi-Annual Cleaning	200.66	8%	13%
Disposal Discount	1.0		

CB Cleanout Data Input - IN THIS STUDY AREA

Assumed Connection of Impervious Area	20%	
Connected Impervious Area (acres)	401	
Number of Catch Basins	12	(initial data from chart to right)
Number of Catch Basins Cleaned (per year)	12	(initial data from chart to right)
Rounds of Cleaning	1.00	

CB Data for Entire Municipality

# CBs in muni.	23
# cleanouts in muni.	23
# study areas in muni.	2

Marina Pumpouts

Number of Pumpouts	
Total Number of berths	0
Boats Served Per Station	160
Fraction of Owners Willing to Use	90%

Load Reduction from Existing Practices (lbs/year)

	N (lbs/year)	P (lbs/year)	TSS (lbs/year)	Bacteria(billion/year)	Volume Reduction (acre-feet)
Pet Waste Education	9	0	0	509	
Erosion and Sediment Control	0	0	0	0	
Street Sweeping	0	0	0	0	
Street Sweeping - Sanding	0	0	0	0	
Structural Stormwater Management Practices	0	0	0	0	0
Structural Stormwater Management Practices - Infiltration	0	0	0	0	
Riparian Buffers	0	0	0	0	0
Riparian Buffers - Infiltration	0	0	0	0	
Catch Basin Cleanouts	223	29	9,981		
Marina Pumpouts	0	0	0	0	
Total Reductions to Surface Water Loads					
Storm Load	233	29	9,981	509	0
Non-storm Load	0	0	0	0	0
Total Reductions to Groundwater Loads. Note: Negative values indicate an *increase* in load (e.g., infiltrating practices may cause an increase in groundwater loads)					
Groundwater Load	0	0	0	0	0

SAMPLE TOWN	SAMPLE River	NON-URBAN	2008

DO NOT ADD OR DELETE ROWS OF CELLS ON THIS TAB - SEVERAL OTHER FILES ARE REFERENCED TO THIS INFORMATION

Existing Loads to Surface Waters

	TN lb/year	TP lb/year	TSS lb/year	Fecal Coliform billion/year	Runoff Volume (acre-feet/year)
Urban Land	56,039	12,458.91	1,275,635	191,248	8,619
Active Construction	-	-	-	-	-
SSOs	4	1	27	3,096	-
CSOs	-	-	-	-	-
Channel Erosion	1,467	1,467	489,073	-	-
Road Sanding	-	-	-	-	-
Forest	45	4	1,780	214	1
Rural Land	9,200	1,400	200,000	78,000	123
Livestock	-	-	-	-	-
Illicit Connections	8	2	54	5,117	-
Marinas	-	-	-	-	-
Point Sources	-	-	-	-	-
Septic Systems	176	29	1,172	934	-
Open Water	-	-	-	-	-
Total Storm Load	62,130	14,909	1,946,323	271,009	8,743
Total Non-Storm Load	4,808	452	21,418	7,599	-
Total Load to Surface Waters	**66,938**	**15,361**	**1,967,741**	**278,608**	**8,743**

Existing Loads to Groundwater (Contributed from Urbanization). Note. Model does not deliver to receiving surface waters.

	TN lb/year	TP lb/year	Fecal Coliform billion/year
Urban Land	292,632	5,565	-
Septic Systems	2,011	44	-
Total	**294,643**	**5,609**	**-**